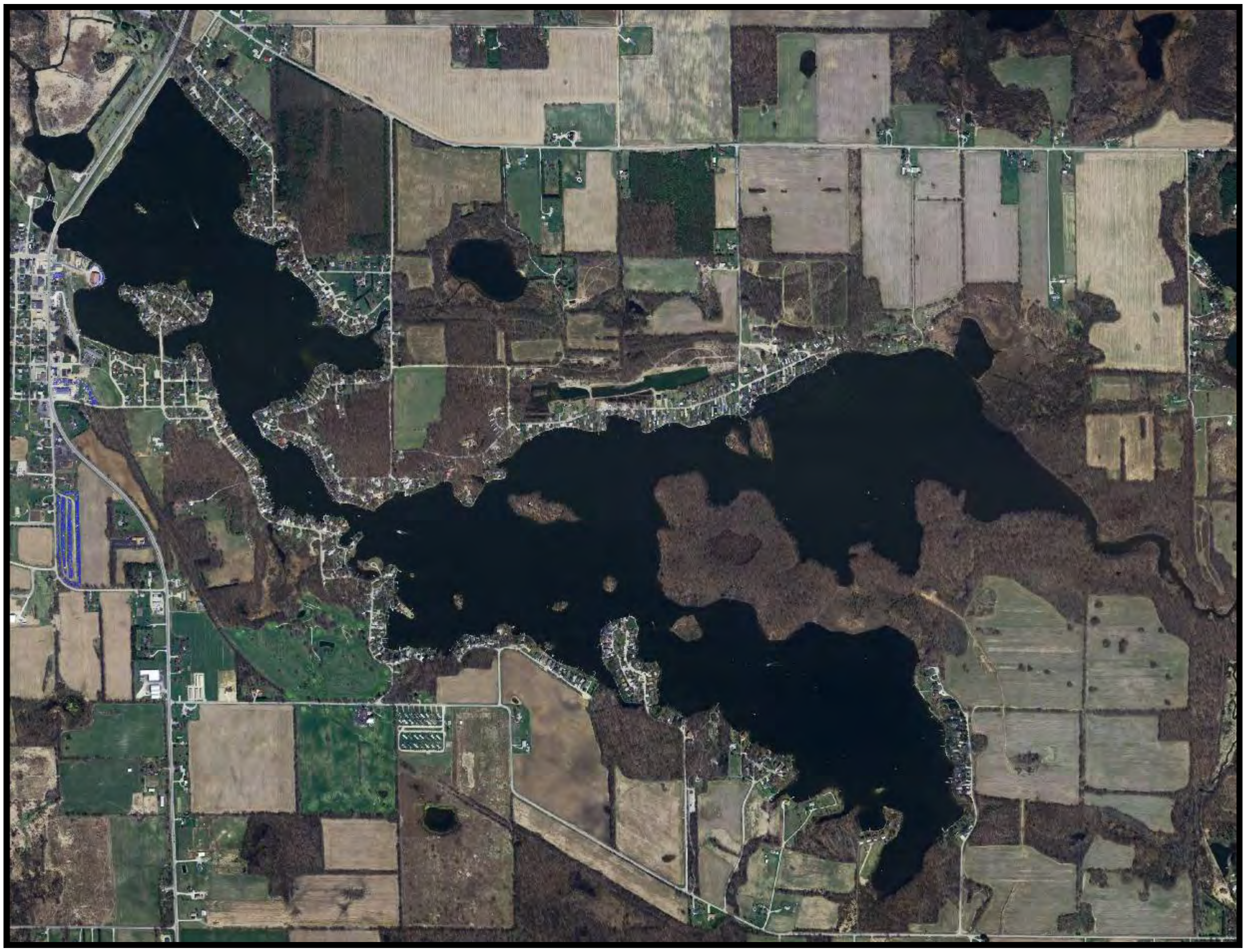
Sylvan Lake Aquatic Plant Management Plan Revision 2007-2011
Noble County, Indiana

6 March 2008



Prepared for:
Sylvan Lake Improvement Association
P.O. Box 696
Rome City, IN 46784

Prepared by:
JFNew
c/o Sara Peel
708 Roosevelt Road
Walkerton, IN 46574
Phone: 574.586.3400 Fax: 574.586.3446

SYLVAN LAKE AQUATIC PLANT MANAGMEENT PLAN REVISION 2007-2011
NOBLE COUNTY, INDIANA

EXECUTIVE SUMMARY

This document is intended to revise the 2005 Aquatic Plant Management Plan and build on aquatic plant treatment efforts within Sylvan Lake, Noble County, Indiana. The following report specifically addresses the results of the aquatic plant chemical treatments conducted during the 2007 season and compares the results with variations in the plant communities at Sylvan Lake over a period of the past two growing seasons. This report captures and interprets information regarding previous aquatic plant management at Sylvan Lake.

In 2007, the only method of control was chemical in nature and was intended to target Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Both species are exotic to Indiana lakes. On May 8, 2007, nearly 265 acres of curly-leaf pondweed were treated by Weed Patrol Inc. (Elkhart, Indiana) within the lake. On June 24, 2007, Weed Patrol Inc. treated approximately 18.5 acres of Eurasian watermilfoil throughout the lake, while the final treatment of coontail (*Ceratophyllum demersum*) occurred over 7.5 acres on August 6 within the upper portion of the lake. Three separate treatments occurred which targeted these three different species. Due to differences in acreage treated and dosage utilized, treatment methodologies differed for the three target species. A low rate of Aquathol K herbicide was used to control curly-leaf pondweed while not harming native pondweeds or other aquatic species. Areas were treated selectively for Eurasian watermilfoil and coontail using 2, 4-D.

Two Tier II surveys were conducted during the spring (May 15 to June 15) and summer (July 15 to August 30). The former is a pre-treatment survey which occurred to determine the nature of the plant community, and the latter is a mid-summer survey to determine how the aquatic plant community responded following treatment. In Sylvan Lake, the spring, pre-treatment survey was completed following the curly-leaf pondweed treatment but prior to the Eurasian watermilfoil treatment. Comparison of 2007 spring and summer Tier II survey data shows that the relative density and abundance of curly-leaf pondweed decreased from the spring to the summer survey. Conversely, relative and mean densities of Eurasian watermilfoil increased from the spring to the summer.

JFNew's review of Tier II surveys from 2003 to 2007 indicates that herbicidal treatment of Eurasian watermilfoil and curly-leaf pondweed are providing control of both these two exotic species in Sylvan Lake. Comparison of spring Tier II survey data from 2003, 2005, and 2007, data indicate that Eurasian watermilfoil mean and relative densities decreased. Eurasian watermilfoil frequency and dominance also decreased from 2003 to 2007. This is not the case for curly-leaf pondweed populations; in 2003, curly-leaf pondweed was present at nearly 45% of the sites, 9% of the sites in 2005 and declined to be present at 29% of the sites in 2007. Mean and relative densities followed a similar patter with increases observed from 2003 to 2005 and decreases from 2005 to 2007. One possible explanation for this is that curly-leaf pondweed in Sylvan Lake has historically undergone less rigorous treatment than treatments targeting Eurasian watermilfoil.

The effects of the treatment on the native aquatic plant community are unclear. Comparing the 2007 spring and summer Tier II survey metrics indicates that the quality of the native aquatic plant community in Sylvan Lake increased following treatment. The native rake diversity (SDI), native species richness and site species native diversity all increased following treatment. However, the number of native plant species found in Sylvan Lake decreased from 11 to 8 from the spring to the summer surveys. Coontail dominated the aquatic plant community following treatment replacing curly-leaf pondweed and Eurasian watermilfoil as the most common and dominant species.

Additional items including a public meeting and a meeting between the contractor, LARE program staff, the district fisheries biologist, and a representative from the Sylvan Lake Improvement Association (SLIA), also occurred in concert with this aquatic plant management plan update. The details of these are not repeated here, but were utilized to generate recommendations as follows:

1. Early season assessment of curly-leaf pondweed populations to determine if treatment is necessary. Treatment should occur when water temperatures approach 50º. At this time, treatment of 300 acres of curly-leaf pondweed is estimated to occur in 2008.
2. Treatment of approximately 300 acres of curly-leaf pondweed throughout Sylvan Lake. Treatment should occur at a rate of 1 mg/L (0.6 to 3.8 gallons/acre depending on depth) of Aquathol K.
3. Treatment of approximately 25 acres of Eurasian watermilfoil throughout Sylvan Lake. Areas are identified in the following sections, but should be confirmed prior to treatment occurring in 2008.
4. Implement control of native species whose growth has reached nuisance levels. Specifically, control of coontail within Sylvan Lake. At this time, it is estimated that control of coontail will cover up to 25 acres in 2008.
5. Continue pre- and post-treatment assessments to determine how the aquatic plant community within Sylvan Lake changes over time.

In 2008, treatment, aquatic plant community assessment, and plan updates are anticipated to cost $121,575. Treatment costs should be reduced over the following years and at a minimum should not exceed $121,575.

Budget <u>estimate</u> for the action plan, 2008-2012.

Task	2008	2009	2010	2011	2012
Curly-leaf pondweed treatment	$97,500	$81,250	$65,000	$48,750	$48,750
Eurasian watermilfoil treatment	$9,375	$9,375	$9,375	$9,375	$9,375
Plant sampling and plan update	$7,500	$7,500	$7,500	$7,500	$7,500
Early-season assessment	$2,200	$2,200	$2,200	$2,200	$2,200
Native plant and algae treatment	$5,000	$5,000	$5,000	$5,000	$5,000
Total	**$121,575**	**$105,325**	**$89,075**	**$72,825**	**$72,825**

ACKNOWLEDGEMENTS

The Indiana Department of Natural Resources Division of Fish and Wildlife as part of the Lake and River Enhancement Program (LARE) provided funding for the development of this plan. The plan has been developed in cooperation with the Sylvan Lake Improvement Association (SLIA). Fieldwork, data analysis and map generation was performed by JFNew with the assistance of the SLIA volunteers. Special thanks to Ralph Cristman for his exceptional driving skills and Jeff Bauermeister and Joe Costello for their input and oversight. Contributors include: Sara Peel, Betsy Ewoldt, and Lynn Cudlip.

TABLE OF CONTENTS

PAGE

1.0 Introduction 1
2.0 Watershed and Lake Characteristics 3
3.0 Lake Uses 9
4.0 Fisheries 11
5.0 Problem Statement 12
6.0 Vegetation Management Goals and Objectives 16
7.0 Plant Management History 17
8.0 Aquatic Plant Community Characterization 21
9.0 Aquatic Vegetation Management Alternatives 34
10.0 Public Involvement 42
11.0 Public Education 43
12.0 Integrated Management Action Strategy 44
13.0 Project Budget 52
14.0 Monitoring and Plan Update Procedures 54
15.0 References Cited 55

LIST OF FIGURES

PAGE

1. General location of the Sylvan Lake watershed 1
2. Land use in the Sylvan Lake watershed 4
3. Sylvan Lake bathymetric map 5
4. Shoreline surface type observed at Sylvan Lake, July 26, 2007 7
5. Lake area uses within Sylvan Lake 9
6. Perceived problems from Sylvan Lake users 10
7. Eurasian watermilfoil (*Myriophyllum spicatum*) 13
8. Curly-leaf pondweed (*Potamogeton crispus*) 13
9. Purple loosestrife (*Lythrum salicaria*) 13
10. Reed canary grass (*Phalaris arundinacea*) 13
11. Eurasian watermilfoil and coontail treatment areas located on Sylvan Lake. Weed Patrol completed treatment for Eurasian watermilfoil on June 25, 2007 and treated for coontail on August 6, 2007 19
12. Curly-leaf pondweed treatment areas located on Sylvan Lake. Weed Patrol completed treatment on June 25, 2007 20
13. Dense curly-leaf pondweed and Eurasian watermilfoil locations identified within Sylvan Lake during the 2007 assessments 23
14. Horned pondweed (state rare species) locations and dominance as surveyed June 4, 2007 25
15. Sampling locations for the Sylvan Lake spring Tier II survey, June 4, 2007 27
16. Eurasian watermilfoil locations and densities as surveyed June 4, 2007 28
17. Curly-leaf pondweed locations and densities as surveyed June 4, 2007 28
18. Sampling locations for the Sylvan Lake summer Tier II survey, July 26, 2007 30
19. Eurasian watermilfoil locations and densities as surveyed July 26, 2007 30
20. Curly-leaf pondweed locations and densities as surveyed July 26, 2007 31
21. An aquatic weed cutter designed to cut emergent weeds along the edge of ponds 36
22. Locations where aquatic macrophytes are often found on boats and trailers 41
23. Typical emergent and rooted floating plant community present in Sylvan Lake 45
24. Eurasian watermilfoil populations targeted for treatment in 2008 47
25. Curly-leaf pondweed populations targeted for treatment in 2008 48
26. Priority areas of coontail treatment in 2008 50

LIST OF TABLES

PAGE

1. Detailed land use in the Sylvan Lake watershed ... 4
2. Morphological characteristics on Sylvan Lake ... 6
3. Prior studies completed in Sylvan Lake and its watershed ... 8
4. Eurasian watermilfoil and curly-leaf pondweed treatment history within Sylvan Lake, 1997 to present (2007) ... 18
5. Tier II sampling strategy for Sylvan Lake using the 2007 Tier II protocol ... 21
6. Survey schedule for pre-treatment and Tier II surveys ... 22
7. Aquatic plant species observed in Sylvan Lake during the spring and summer surveys completed June 4 and July 26, 2007 ... 24
8. Spring (pre-treatment) Tier II survey metrics and results as collected June 4, 2007 ... 26
9. Summer (post-treatment) Tier II survey metrics and results as collected July 26, 2007 ... 29
10. A comparison of the aquatic plant community in Sylvan Lake with the average values for plant community metrics found by Pearson (2004) in his survey of 21 northern Indiana lakes ... 31
11. Variation in site frequency, relative and mean density, and dominance of Eurasian watermilfoil and curly-leaf pondweed within Sylvan Lake from 2003 to 2007 ... 33
12. Budget <u>estimate</u> for the action plan, 2008-2012 ... 52

LIST OF APPENDICES

Appendix A: Lake User Survey Results
Appendix B: Tier II survey raw data
Appendix C: Tier II survey results
Appendix D: Hydrilla Information
Appendix E: 2008 Aquatic Plant Treatment Permit Applications

SYLVAN LAKE AQUATIC PLANT MANAGEMENT PLAN REVISION 2007-2011
NOBLE COUNTY, INDIANA

1.0 Introduction

This report serves as a revision to the 2005 Draft Sylvan Lake Aquatic Plant Management Plan (Weed Patrol, Inc., 2005 draft). This revision will serve as a tool to track changes in the vegetative community, to adjust the action plan as needed, and to maintain eligibility for additional LARE funds. Items covered include a review of details of the 2006 and 2007 vegetation control efforts; spring and summer Tier II results from the 2007 season; a comparison of Tier II results from 2003 to 2007 completed by the IDNR, Weed Patrol, and JFNew; a recap from the public meeting and the planning meeting; and a discussion of potential management implications of the results. The plan update was funded by the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement Program (LARE) and the Sylvan Lake Improvement Association (SLIA). This is the third year that that the SLIA has been involved in aquatic plant management planning through the LARE program.

Sylvan Lake is a 669-acre impoundment that lies in the northeast corner of Noble County, Indiana (Figure 1). Specifically, the lake is located in Sections 9, 10, 13, 14, 15, 16, 22, and 23 of Township 35 North, Range 10 East in Noble County. The Sylvan Lake watershed stretches out to the east and south of the lake encompassing approximately 21,694.6 acres (33.9 square miles). Water discharges through the lake's outlet in the northwest corner. Water from Sylvan Lake's outlet flows west to combine with water from Waldron Lake. Water from Waldron Lake exits through the North Branch of the Elkhart River flowing west to empty into the Elkhart River between Ligonier and Wawaka, Indiana. The Elkhart River transports water to the St. Joseph River, which eventually discharges into Lake Michigan.

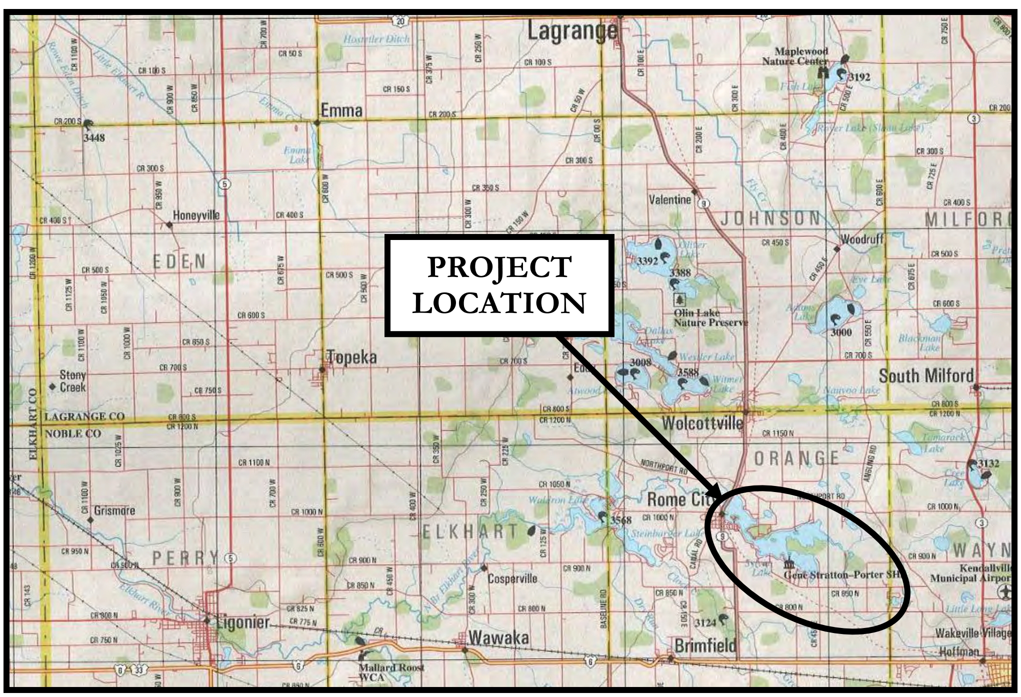


Figure 1. General location of the Sylvan Lake watershed. Source: DeLorme, 1998.

During the 2007 growing season the following actions were taken.

- May 8, 2007: 265 acres of curly-leaf pondweed treated.
- June 4, 2007: Tier II spring aquatic plant survey completed.
- June 25, 2007: 15 acres of Eurasian watermilfoil treated.
- July 26, 2007: Summer Tier II aquatic plant surveys completed.
- August 10, 2007: 7.5 acres of coontail treated.
- October 24, 2007: Public meeting to discuss initial aquatic plant survey results and treatment.
- November 9, 2007: Meeting between the SLIA, JFNew, and IDNR to discuss 2008 treatment options.

2.0 Watershed and Lake Characteristics

2.1 Watershed Characteristics

Sylvan Lake is a headwaters lake in the Great Lakes Basin. Surface water drains to Sylvan Lake via three primary routes: through Henderson Ditch, through an unnamed tributary which enters through the northwest corner of the lake, and via direct drainage. Oviatt Ditch drains into Henderson Ditch before it reaches Sylvan Lake. Henderson Ditch empties into Sylvan Lake in the lake's northeast corner. This ditch is a legal drain, which means that the drain is maintained by the drainage board. Furthermore, any activity in and around the drain must be approved by the drainage board prior to the activity occurring. An unnamed tributary transports water to Sylvan Lake from the watershed north of the lake emptying into the lake along its northern boundary.

2.1.2 Land Use

Figure 2 and Table 1 present current land use information for the Sylvan Lake watershed. Like many Indiana watersheds, agricultural land use dominates the Sylvan Lake watershed, accounting for approximately 68% of the watershed. Row crop agriculture makes up the greatest percentage of agricultural land use at 55.1%, while pastures or hay vegetate another 13.0%. Land uses other than agriculture account for the remaining 32% of the watershed. Natural landscapes, including forests and wetland, cover approximately 16.3% of the watershed. Most of the natural acreage in the watershed is associated with the forested and emergent and woody wetland area north and east of Sylvan Lake. Most of the remaining 20% of the watershed is occupied by low intensity residential land, with less than 1% of high intensity residential and 3.6% of high intensity commercial land.

Table 1. Detailed land use in the Sylvan Lake watershed.

Land Use	Area (acres)	Area (hectares)	% of Watershed
Row Crops	11,959.5	4,839.8	55.1%
Pasture/Hay	2,819.6	1,141.0	13.0%
Open Water	1,292.0	522.9	6.0%
Deciduous Forest	2,246.3	909.1	10.4%
Woody Wetlands	813.8	329.3	3.8%
Low Intensity Residential	844.4	341.7	3.9%
Emergent Herbaceous Wetlands	206.9	83.7	1.0%
Evergreen Forest	41.3	16.7	0.2%
High Intensity Commercial	778.2	314.9	3.6%
High Intensity Residential	167.1	67.6	0.8%
Other Grasses	411.2	166.4	1.9%
Quarries	99.4	40.2	0.5%
Transitional	12.7	5.1	<0.1%
Mixed Forest	2.2	0.9	<0.1%
Entire Watershed	**21,694.6**	**8,779.5**	**100.0%**

Source: USGS EROS, 1998.

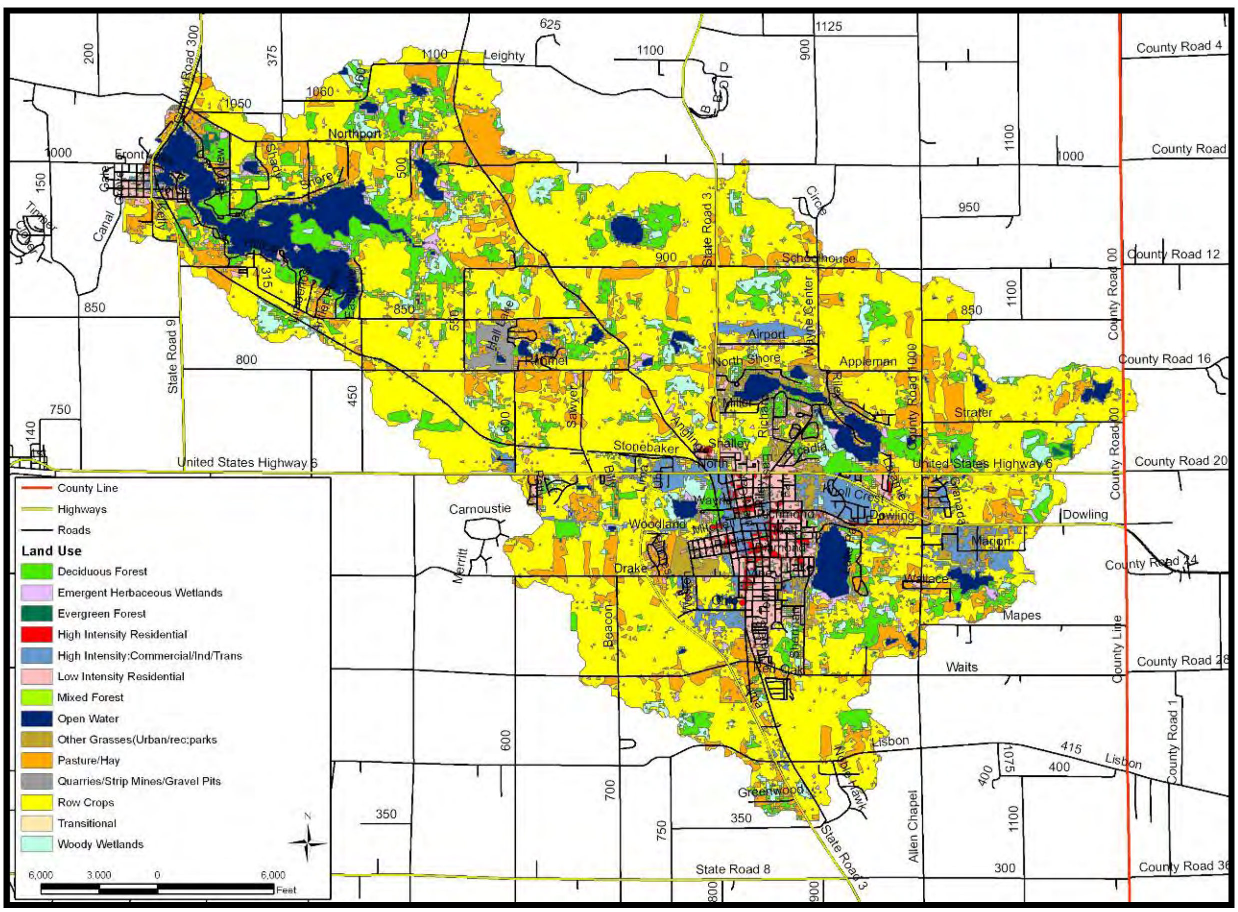


Figure 2. Land use in the Sylvan Lake watershed.
Source: USGS EROS, 1998.

2.2 Lake Characteristics

2.2.1 Morphology

Figure 3 presents Sylvan Lake's morphology. The lake consists of two deep basins surrounded by shallower water. The lake's deepest point lies in the southeast basin of the 669-acre lake. Here, the lake extends to its maximum depth of 33 feet (10 m; Table 2). One shallower hole lies east of the deepest hole in the lake reaching a maximum depth of 30 feet (9.1 m).

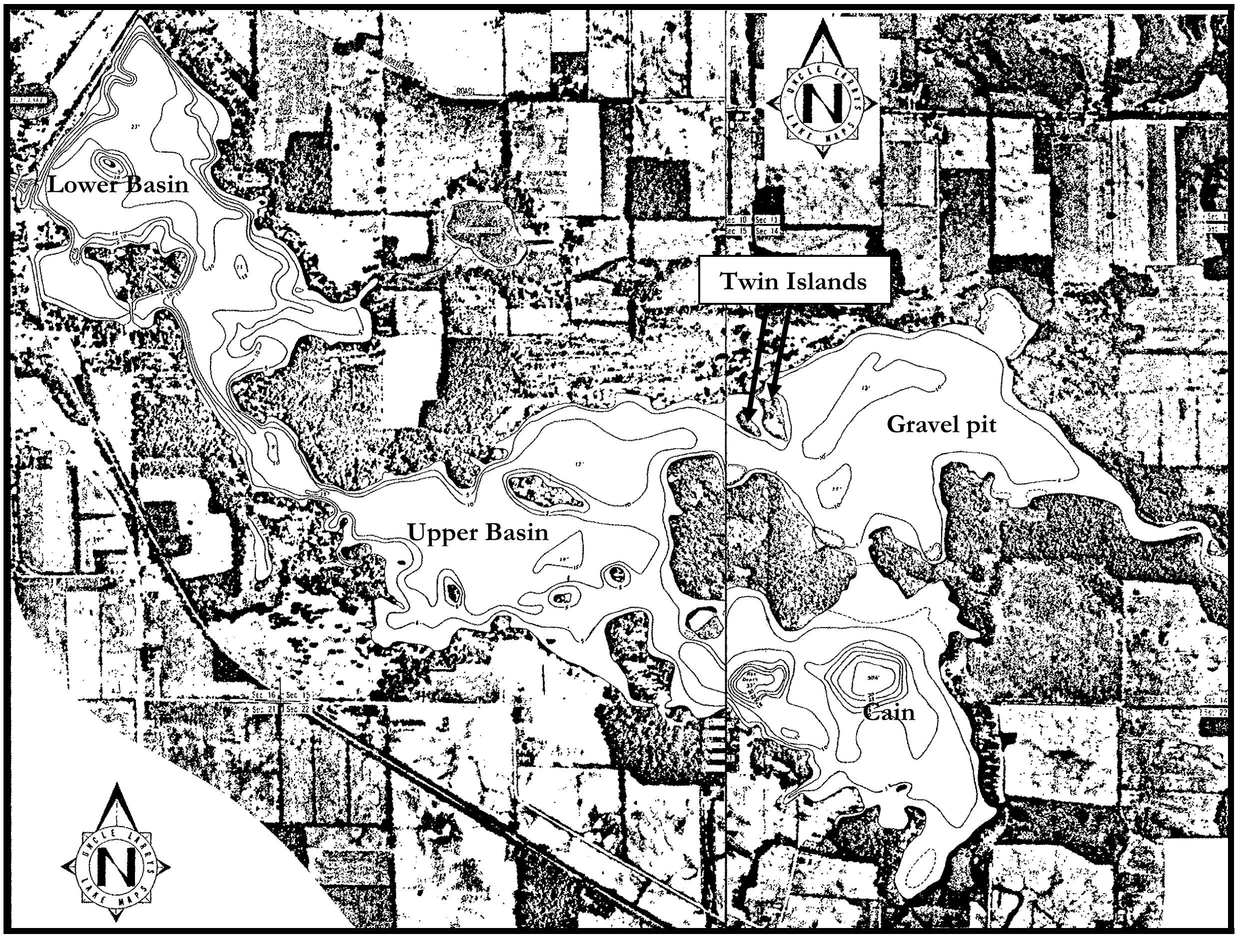


Figure 3. Sylvan Lake bathymetric map. Source: Indiana Department of Conservation, 1927.

Table 2 summarizes the surface area, volume, and other geographic information for Sylvan Lake and its watershed. Sylvan Lake possesses various expanses of shallow water. The lake's area gradually increases with depth to a water depth of about 10 feet (3 m) before the rate of change increases. This rate (slope of lake bottom) continues to the lakes maximum depth (33 feet or 10 m). Sylvan Lake holds approximately 6,690 acre-feet of water.

A lake's morphology can play a role in shaping the lake's biotic communities. For example, Sylvan Lake's moderately sized shallow area and wide, shallow shelf around much of the perimeter of the lake coupled with its adequate water clarity suggests that the lake is capable of supporting a quality rooted plant community. Based on the lake's clarity, Sylvan Lake's littoral zone (or the zone capable of supporting aquatic rooted plants) extends from the shoreline to the point where water depths are approximately 15 feet (4.6 m).

A lake's morphology can also indirectly influence water quality by shaping the human communities around the lake. The shoreline development ratio is a measure of the development potential of a lake. It is calculated by dividing a lake's shoreline length by the circumference of a circle that has the same area as the lake. A perfectly circular lake with the same area as Sylvan Lake (669 acres) would have a circumference of 19,136 feet. Dividing Sylvan Lake's shoreline length (71,175 feet) by 19,136 feet yields a ratio of 3.7:1. This ratio is relatively high. Sylvan Lake is relatively convoluted and possesses extensive shoreline along various points and coves. Given the immense popularity of lakes in northern Indiana, lakes with high shoreline development ratios are often highly developed. Increased development around lakes often leads to decreased water quality.

Table 2. Morphological characteristics of Sylvan Lake.

Characteristic	Value
Surface Area	669 acres
Volume	6,690 acre-feet
Maximum Depth	33 feet
Mean Depth	10 feet
Shoreline Length	71,157 feet
Shoreline Development Ratio	3.7
Residence Time	0.7 years (256 days)

2.2.2 Shoreline Development

Given the number of houses along Sylvan Lake's shoreline, it is not surprising that nearly 59% of Sylvan Lake's shoreline has been altered in some form. Along much of Sylvan Lake's shoreline (41%; 29,054 feet), trees and emergent vegetation have remained untouched; however, these areas are still affected by wave action and boat traffic (Figure 4). These areas are mapped as natural shoreline because they possess a large portion of all three aquatic vegetation strata (submerged, emergent, and floating). Other portions of the shoreline that are also mapped as natural include the islands in the lake that have been modified very little or not at all.

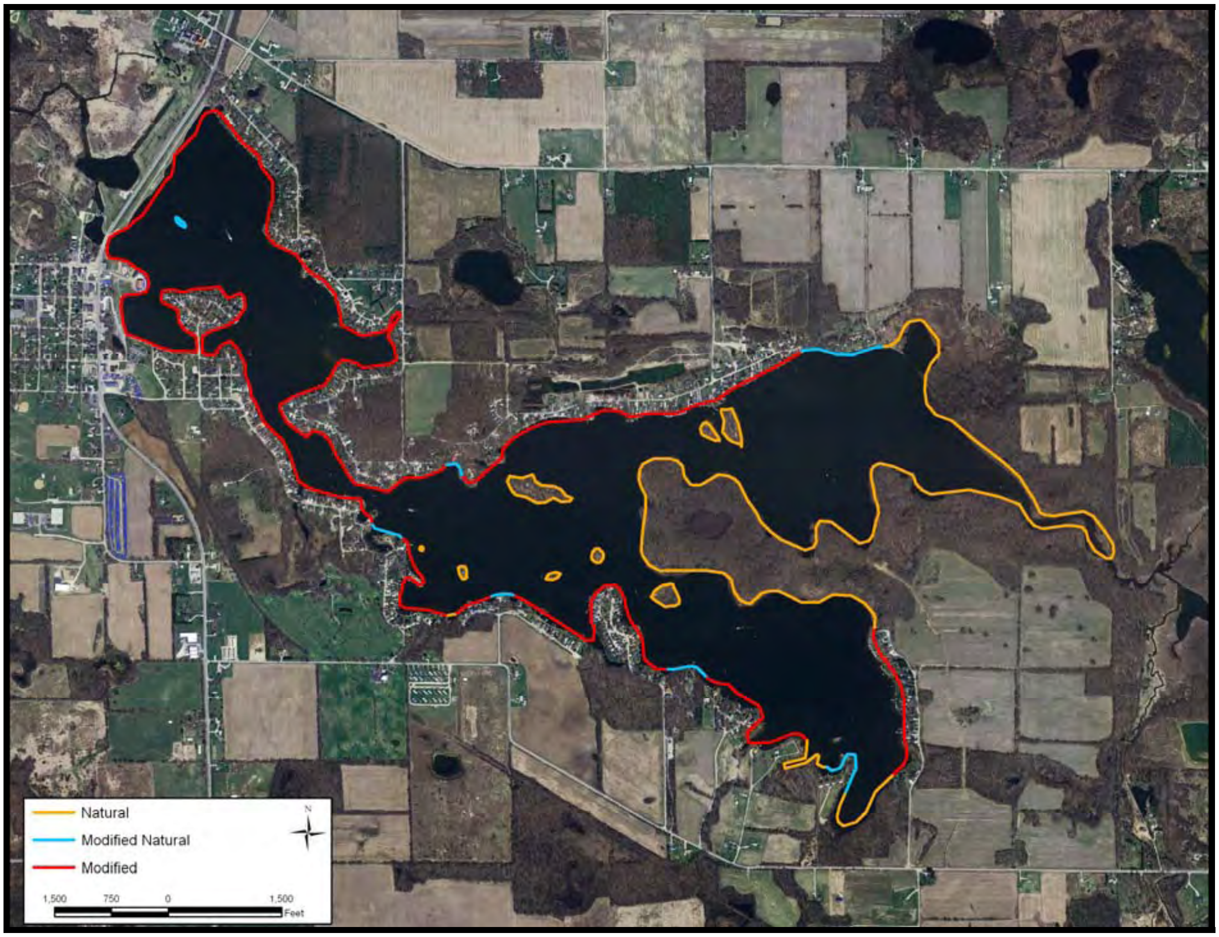


Figure 4. Shoreline surface type observed at Sylvan Lake, July 26, 2007.

Approximately 53% of Sylvan Lake's shoreline has been largely altered from its natural state (Figure 4). Along these portions of Sylvan Lake's shoreline, emergent and floating rooted vegetation has been completely removed from adjacent to the shoreline. A majority of this shoreline has been converted to concrete or stone seawall. Natural shoreline remains along approximately 41% of Sylvan Lake's shoreline. Most of the natural shoreline areas include emergent, floating rooted vegetation, and wetland areas that have not been impacted by development yet.

The shoreline surface becomes especially important in and adjacent to shallow portions or narrow areas of Sylvan Lake. In areas where concrete seawalls are present, wave energy from wind and boats strike the flat surface and reflect back into the lake. This creates an almost continuous turbulence in the shallow areas of the lake. At points where the waves reflect back into the lake and meet incoming waves, the wave height increases resulting in additional in-lake turbulence. This turbulence re-suspends bottom sediments thereby increasing the transfer of nutrients from the sediment-water interface to the water column. Continuous disturbance in shallow areas can also encourage the growth of disturbance-oriented plants.

In contrast, shorelines vegetated with emergent or rooted floating vegetation or those areas covered by sand will absorb more of the wave energy created by wind or boats. In these locations, wave energy will dissipate along the shoreline each time a wave meets the shoreline surface. Similarly, stone seawalls or those covered by wood can decrease shallow water turbulence and lakeward wave energy reflection while still providing shoreline stabilization.

2.2.3 Historic Assessments

A number of studies and projects have been completed within Sylvan Lake over its history. Table 3 lists prior studies conducted in the Sylvan Lake watershed.

Table 3. Prior studies completed in Sylvan Lake and its watershed.

Year	Entity	Topic	Study
1839			Completion of dam forming Sylvan Lake
1904			Construction of present concrete dam
1931	ISBH	Water Quality	Survey indicates lake is unfit for bathing due to untreated sewage
1927	IDC		Bathymetric study
1936		Water Quality	Survey reports massive algal bloom at eastern end of lake
1937	IDC	Water Quality	Evaluation of nutrient enrichment from Kendallville sewage.
1937		Water Quality	Survey: Nutrient enrichment problem is from Kendallville sewage
1939	IU	Fisheries	Examination of bluegill growth rates in Sylvan Lake
1965	IU	Fisheries	Assessment of growth of bluegill in Sylvan Lake
1967	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1970	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1974-75	IDNR	Water Quality	Drawdown of Sylvan Lake for installation of sewer lines
1975-76	IDNR	Water Quality	Drawdown of Sylvan Lake for installation of sewer lines
1976	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1976	USGS		Construction of bathymetric map for Sylvan Lake
1977	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1978	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1980	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1981	IDNR	Fisheries	Survey of fish community in Sylvan Lake
1985	IDNR	Fisheries	Survey of fish community
1986	IDNR	Fisheries	Survey of fish community
1987	IDNR	Fisheries	Survey of fish community
1988	IDNR	Water Quality	Water clarity investigation
1990	Crisman	Water Quality	Final Feasibility Report for Sylvan Lake
1991	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
1994	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
1996	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
2002	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
2003	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
2005	IDNR	Fisheries	Sylvan Lake Fisheries Management Report
2005	Weed Patrol	Water Quality	Sylvan Lake Aquatic Plant Management Plan Draft

ISBH=Indiana State Board of Health
IDC=Indiana Department of Conservation
IDNR=Indiana Department of Natural Resources
USGS=United States Geological Survey

3.0 Lake Uses

General lake use areas and high quality, natural shorelines are identified in Figure 5. Specifically, the undeveloped shoreline areas in Sylvan Lake are shown in red in Figure 5. Wave action from skiing and fast speed boating impacts natural shorelines on the east side and along all the islands on the east half of Sylvan Lake. The high use areas in Sylvan Lake are found throughout the lake. These areas in the lake are shown in green.

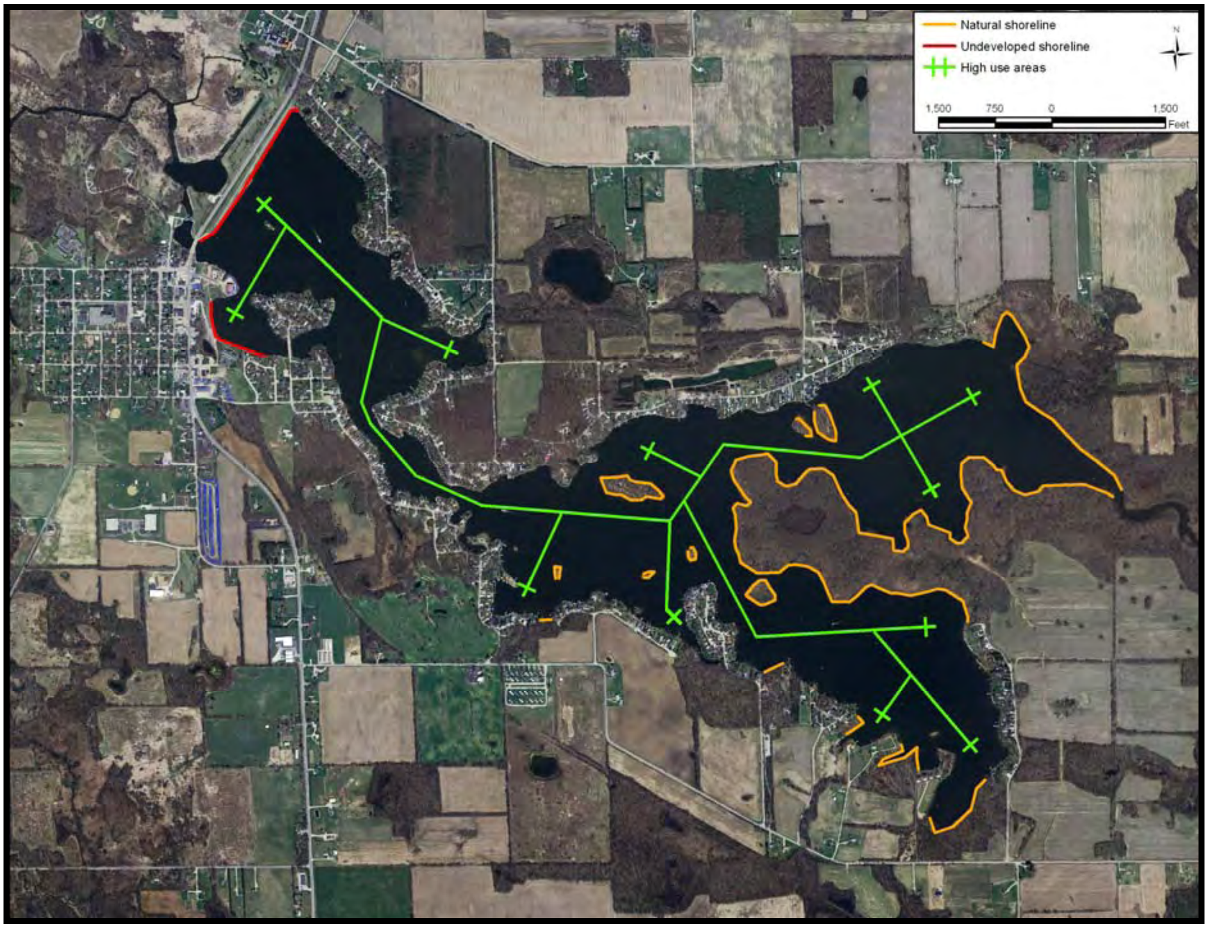


Figure 5. Lake use areas within Sylvan Lake.

A public meeting was held October 24, 2007 to discuss aquatic plant survey results and to conduct a user survey regarding the use of Sylvan Lake and its aquatic plant management program. (Appendix A contains detailed results from the user survey.) Thirty-two lake users responded to the survey this year. The responses from meeting attendees indicate that nearly all of them use the lake for boating (97%) and swimming (93%), while a high percentage use the lake for fishing (85%). Another 53% of respondents indicated that Sylvan Lake is used for irrigation. Sylvan Lake is primarily a recreational lake; therefore, these responses are in line with expectations.

Respondents were also questioned about their perceived problems with the lake. Figure 6 details the responses of users in regards to perceived problems in Sylvan Lake. The main concern of Sylvan Lake users is that too many aquatic plants are present in the lake (91%). Dredging needs were identified by 75% of respondent, while 53% identified poor water quality within Sylvan Lake as a problem. Concerns regarding too many boats or jet skis (or other personal watercraft) on the lake and those dealing with perceived overuse of the lake by non-residents are an issue for 22% of Sylvan Lake users. Complaints about non-resident use include noise pollution, speeding on and off the lake, and installation of docks at non-resident locations. Only 9.4% of lake users think that funneling or fish population issues are a problem.

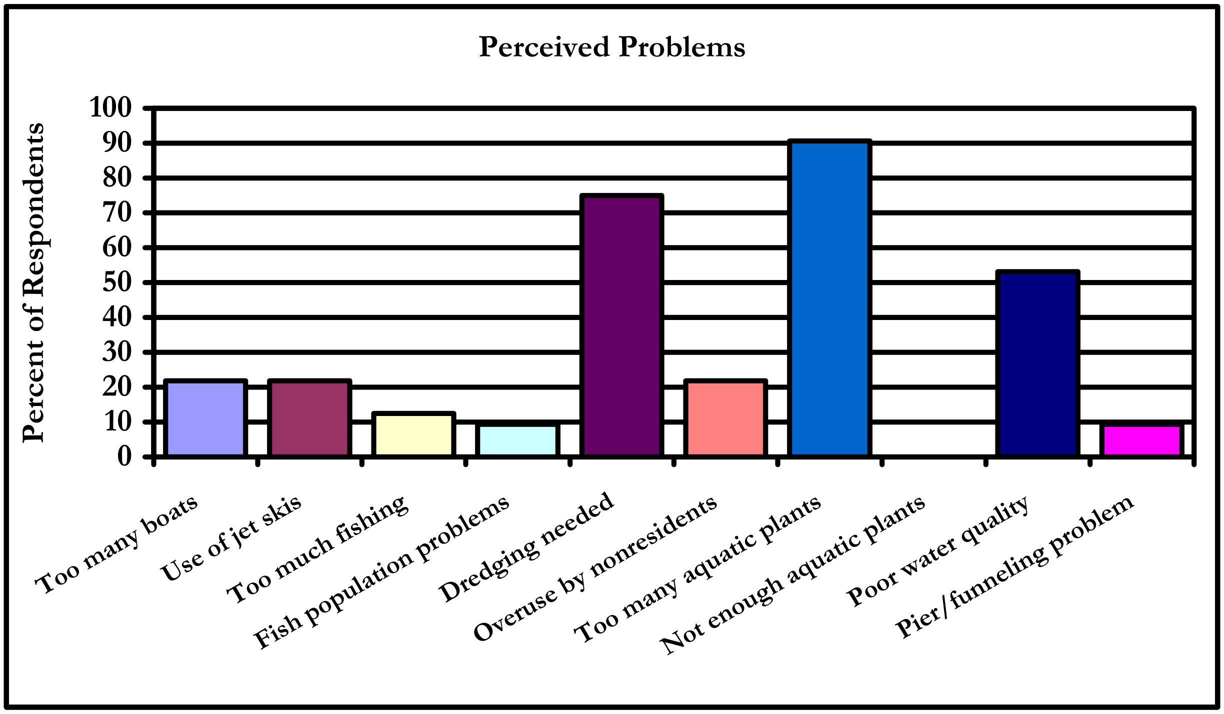


Figure 6. Perceived problems from Sylvan Lake users.

Many lake users commented on the need for additional weed control in the lake and realize that they may have too many invasive aquatic plant species and not enough native plant species. The need to treat Eurasian watermilfoil will continue to be a priority for this lake. There were only one or two specific comments about dredging even though 53% of users thought it is necessary. A consensus, which the survey did not provide, on locations that need to be dredged would help determine whether or not there is a serious issue in Sylvan Lake.

4.0 Fisheries

The DNR conducted fish surveys at Sylvan Lake each year from 1976 to 1981. Historically, Sylvan Lake was considered a fishing destination. However, fishing deteriorated in the 1960s and 1970s resulting in the DNR completing a carp eradication project on Sylvan Lake in 1984. Following the eradication project, the lake was restocked with bluegill, largemouth bass, and channel catfish. Subsequent surveys were performed in 1985, 1986, 1987, 1991, 1996, 2002, 2003, and 2005. Based on these surveys, additional annual and biennial stocking of channel catfish, walleye, and small mouth bass was recommended. No evidence of a return to pre-eradication conditions was noted during any of the surveys following the eradication project. Additionally, Sylvan Lake continues to be managed for Walleye. Specific information regarding the fish community and the fish that comprise it are available from the DNR.

5.0 Problem Statement

The composition and structure of the lake's rooted plant community often provide insight into the long term water quality of a lake. While sampling the lake water's chemistry (dissolved oxygen, nutrient concentrations, etc.) is important, water chemistry sampling offers a single snapshot of the lake's condition. Because rooted plants live for many years in a lake, the composition and structure of this community reflects the water quality of the lake over a longer term.

The composition and structure of a lake's rooted plant community also help determine the lake's fish community composition and structure. Submerged aquatic vegetation provides cover from predators and is a source of forage for many different species of fish (Valley et al., 2004). However, extensive and dense stands of exotic aquatic vegetation can have a negative impact on the fish community. For example, a lake's bluegill population can become stunted because dense vegetation reduces their foraging ability, resulting in slower growth. Additionally, dense stands reduce predation by largemouth bass and other piscivorous fish on bluegill which results in increased intraspecific competition among both prey and predator species (Olsen et al., 1998). Vegetation removal can have variable results on improving fish growth rates (Cross et al., 1992, Olsen et al., 1998). Conversely, lakes with depauperate plant communities may have difficulty supporting some top predators that require emergent vegetation for spawning. In these and other ways, the lake's rooted plant community illuminates possible reasons for a lake's fish community composition and structure.

A lake's rooted plant community impacts the recreational uses of the lake. Swimmers and power boaters desire lakes that are relatively plant-free, at least in certain portions of the lake. In contrast, anglers prefer lakes with adequate rooted plant coverage, since those lakes offer the best fishing opportunity. Before lake users can develop a realistic management plan for a lake, they must understand the existing rooted plant community and how to manage that community. This understanding is necessary to achieve the recreational goals lake users may have for a given lake.

Sylvan Lake is primarily a recreational lake. Its primary uses are fishing, swimming, high speed boating, and pleasure boating. As detailed in Figure 5, much of the shoreline is developed. However, several areas are maintained in their native form and should be protected. These areas are demarcated in Figure 5 and include, but are not limited to Boy Scout Island, which will soon be converted to IDNR-owned property. High use areas are shown in Figure 5. Finally, it should be noted that the upper shallow basins of the lake are not typically used for high speed activities.

5.1 Nuisance and Exotic Plants

Although they have not yet reached the levels observed on many other regional lakes, several nuisance and/or exotic aquatic plant species grow in Sylvan Lake. As nuisance species, these species will continue to proliferate if unmanaged, so data collected during the plant survey will be outdated quickly and should not be used to precisely locate nuisance species individuals or stands. (Additionally, it is likely that the watershed supports many terrestrial nuisance species plant species, but the discussion in this report will focus on the aquatic nuisance species.) The plant survey revealed the presence of two submerged, aggressive exotics: Eurasian watermilfoil (Figure 7) and curly-leaf pondweed (Figure 8). Sylvan Lake also supports two emergent exotic plant species: purple loosestrife (Figure 9) and reed canary grass (Figure 10). As exotic invasive species, these species also have the potential to proliferate if left unmanaged.

Figures 7. Eurasian watermilfoil (*Myriophyllum spicatum*) and 8. Curly-leaf pondweed (*Potamogeton crispus*).

Figure 9. Purple loosestrife (*Lythrum salicaria*) and Figure 10. Reed canary grass (*Phalaris arundinacea*).

5.1.1 Eurasian watermilfoil

The presence of Eurasian watermilfoil in Sylvan Lake is of concern, but it is not uncommon for lakes in the region. Eurasian watermilfoil is an aggressive, non-native species common in northern Indiana lakes. It often grows in dense mats excluding the establishment of other plants. For example, once the plant reaches the water's surface, it will continue growing horizontally across the water's surface. This growth pattern has the potential to shade other submerged species preventing their growth and establishment. In addition, Eurasian watermilfoil does not provide the same habitat potential for aquatic fauna as many native pondweeds. Its leaflets serve as poor substrate for aquatic insect larvae, the primary food source of many panfish.

5.1.2 Curly-leaf pondweed

Depending upon water chemistry, curly-leaf pondweed can be more or less aggressive than Eurasian watermilfoil. Its presence in the lake is a concern because, like Eurasian watermilfoil, curly-leaf pondweed can spread across the lake's surface forming dense mats ultimately shading out native species. Like many exotic invasive species, curly-leaf pondweed gains a competitive advantage over native submerged species by sprouting early in the year. The species can do this because it is more tolerant of cooler water temperature than many of the native submerged species. Curly-leaf pondweed experiences a die-back during early to mid-summer. This die-back can degrade water quality by releasing nutrients into the water column and increasing the biological oxygen demand.

5.1.3 Purple loosestrife

Purple loosestrife is an aggressive, exotic species introduced into this country from Eurasia for use as an ornamental garden plant. Like Eurasian watermilfoil, purple loosestrife has the potential to dominate habitats, in this case wetland and shoreline communities, excluding native plants. The stiff, woody composition of purple loosestrife makes it a poor food source substitute for many of the native emergents it replaces. In addition, the loss of diversity that occurs as purple loosestrife takes over plant communities lowers the wetland and shoreline habitat quality for waterfowl, fishes, and aquatic insects.

5.1.4 Reed canary grass

Like purple loosestrife, reed canary grass is native to Eurasia. Farmers used (and many likely still use) the species for erosion control along ditch banks or as marsh hay. The species escaped via ditches and has spread to many of the wetlands in the area. Swink and Wilhelm (1994) indicate that reed canary grass commonly occurs at the toe of the upland slope around a wetland. Reed canary grass was often observed above the ordinary high water mark around Sylvan Lake. Like other nuisance species, reed canary grass forms a monoculture mat excluding native wetland/shoreline plants. This limits a wetland's or shoreline's diversity ultimately impacting the habitat's functions.

5.1.5 Hydrilla

Although it was not identified in Sylvan Lake during the aquatic plant survey, another exotic, invasive species, hydrilla, was identified for the first time in Indiana at Lake Manitou in Fulton County in 2006. Hydrilla is a submerged plant that resembles common waterweed. However, hydrilla can tolerate lower light levels and higher nutrient concentrations than most native aquatic species. Because of its special adaptations, hydrilla can live in deeper water and photosynthesize earlier in the morning than other aquatic species. Because of these factors, hydrilla is often present long before it becomes readily apparent. It often grows quickly below the water and becomes obvious only after out-competing other species and forming a monoculture. Dense mats of hydrilla often cause pH imbalances and temperature and dissolved oxygen fluctuations. This allows hydrilla to out-compete other aquatic-plant species and can cause imbalances in the fish community.

5.2 Exotic Plants in Sylvan Lake

Previous aquatic plant assessments identified the predominance of curly-leaf pondweed and the presence of Eurasian watermilfoil as the two primary exotic nuisance species located within Sylvan Lake. Following the 2005 assessment, a permit application was submitted to the IDNR to treat approximately 300 acres of curly-leaf pondweed, 15 acres of Eurasian watermilfoil, and 50 acres each of filamentous algae and coontail. A similar permit application was submitted in 2006 for treatment of curly-leaf pondweed, Eurasian watermilfoil, coontail, and algae. In total, 120 acres of curly-leaf pondweed were treated throughout Sylvan Lake in both 2005 and 2006. In 2005, Eurasian watermilfoil was treated on concert with coontail treatment which covered approximately 20 acres. In 2006, 20 acres of Eurasian watermilfoil were treated throughout Sylvan Lake. These species continue to be problematic throughout the areas previously identified.

6.0 Vegetation Management Goals and Objectives

Listed below are three goals formulated by the LARE program staff and the IDNR Division of Fish and Wildlife Biologists and approved by the Sylvan Lake improvement Association. The objectives and actions used to meet the goals are discussed in the **Management Action Strategy Section**.

Aquatic Plant Management Goals:

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish and wildlife resources.

Historic treatment efforts support these three goals. Efforts to control the growth and spread of curly-leaf pondweed and Eurasian watermilfoil should eventually result in a stable, diverse, native aquatic plant community. Specific outcomes of the current year's treatment efforts will be discussed in further detail in subsequent sections.

7.0 Plant Management History

Aquatic plants have long been a problem at Sylvan Lake. In 1930, nearly 90 years after the lake's construction date, aquatic plant growth was considered excessive (Crisman, 1990). Aquatic plant and algal problems were again recognized as an issue in the 1950s prompting residents to develop a management plan. This plan resulted in winter drawdowns for aquatic plant control, which occurred from 1958 to 1960. Subsequent aquatic plant and algal control methods included the use of more than six barrels of an arsenic-based chemical for algal control, multiple summer and winter drawdowns, and the application of thousands of gallons of herbicide for aquatic plant control (Crisman, 1990). All of these efforts resulted in a virtual elimination of aquatic plants within the lake by the mid-1960s. Subsequent surveys identified an algae-dominated lake in 1967; total absence of submerged plants and emergent plants limited to a narrow fringe covering less than 10% of the lake's surface area in 1976; and plants growing to a depth of two to three feet in 1977 (Crisman, 1990).

In combination with aquatic plant control strategies enacted by Sylvan Lake residents, the fish community within the lake deteriorated as well. From 1967 to 1987, 27 species of fish were identified in Sylvan Lake (Crisman, 1990). In the 1960's, carp comprised 8 percent of the fish community but accounted for 70 percent of the fish community by weight. Drawdown efforts were attempted for control of carp in the 1970's; however, they continued to be a problem accounting for 50 percent of the fish community by weight in Sylvan Lake. Additionally, the DNR suggested that the large carp population was increasing water turbidity and reducing water quality in Sylvan Lake due to their bottom forage and feeding behavior. To improve water quality, habitat, and the fishery, Sylvan Lake's fishery was renovated in 1984. Stocking of the fish community followed renovation. Crisman (1990) reported "dramatic improvement" in the fishery, better water clarity, and improved habitat; specifically in the form of submerged aquatic vegetation.

In 1985, IDNR biologists identified several submerged species that were not observed in Sylvan Lake over the previous 20 years. Additionally, leafy pondweed (*Potamogeton foliosus*) was noted as the dominant species during the 1985 assessment (Pearson, 1987). A resurgence in the lake's aquatic plant community occurred over the next two years. Plants were observed to a depth of six to eight feet in 1986 with curly-leaf pondweed dominating the plant community. Additionally, plants grew to a depth of twelve feet in 1987 and a more diverse community was observed throughout the lake. Pearson (1987) noted that aquatic plants were scarce in Sylvan Lake, which typically contained areas with pockets of aquatic vegetation. Additionally, Pearson noted the lack of emergent plants along Sylvan Lake's shoreline. Pearson stressed the need for shoreline residents and lake users to recognize the need for aquatic plants within the lake and also stressed the relationship between a healthy plant community and good fishing and water quality.

Between 1987 and 1997, aquatic plant treatment within Sylvan Lake was limited to individual residences along the shoreline of the lake (Weed Patrol, 2005 draft). During this ten year period, management of the aquatic plant community focused on the growth of a diverse community throughout as much of the lake as possible without limiting individual's use of the lake for regular recreational activities. Eurasian watermilfoil treatment began in 1997 and continued with wide-spread treatment throughout the lake for three out of four years from 1997 to 2000 (Weed Patrol, 2005 draft). Since that time, spot treatment of Eurasian watermilfoil and curly-leaf pondweed occurred throughout the lake. The focus of these treatments continues to be the developed areas of the lake near the lake's outlet. This results in the upstream portions of the lake not being treated.

These areas may act as a nursery for both Eurasian watermilfoil and curly-leaf pondweed. Table 4 displays the treatment of exotic species, namely curly-leaf pondweed and Eurasian watermilfoil, since 1997.

Table 4. Eurasian watermilfoil and curly-leaf pondweed treatment history within Sylvan Lake, 1997 to present (2007).

Year	Eurasian watermilfoil acreage	Curly-leaf pondweed acreage
1997	129	0
1998	79	0
1999	7	80
2000	75	88.5
2001	20	90
2002	12	99
2003	15	85
2004	10	94
2005	0	120
2006	20	120
2007	18.5	265

On May 8, 2007, Weed Patrol treated 265 acres of curly-leaf pondweed. Additionally, on June 25, 2007, Weed Patrol treated a total of 18.5 acres of Eurasian watermilfoil. Both treatments occurred during sunny conditions (approximately 70ºF) with a light wind. A third treatment which was not funded by the LARE program occurred on August 6, 2007 for coontail (approximately 7.5 acres). Figures 11 and 12 indicate the specific locations, plant species targeted, and size of area targeted during the aforementioned herbicide application. For selective Eurasian watermilfoil control, roughly 2 ppm of 2,4-D herbicide (approximately 1 gallon per acre depending on the depth and size of the area) was applied. Often an herbicide can be applied at a lighter rate when treating big areas. For curly-leaf pondweed control, 0.5 mg/L of Aquathol K herbicide was used (applied at a rate of approximately 1 gallon per acre). This low rate was used to control curly-leaf pondweed, which is more sensitive to Aquathol, while not killing native pondweeds (Tony Cunningham, Weed Patrol, Inc, personal communication). For both treatments, herbicide was applied by making narrow passes through the treatment area. Coontail was treated with Reward at a rate of 1.5 gal/acre. No additional treatment occurred on Sylvan Lake that was not funded through the IDNR LARE program.

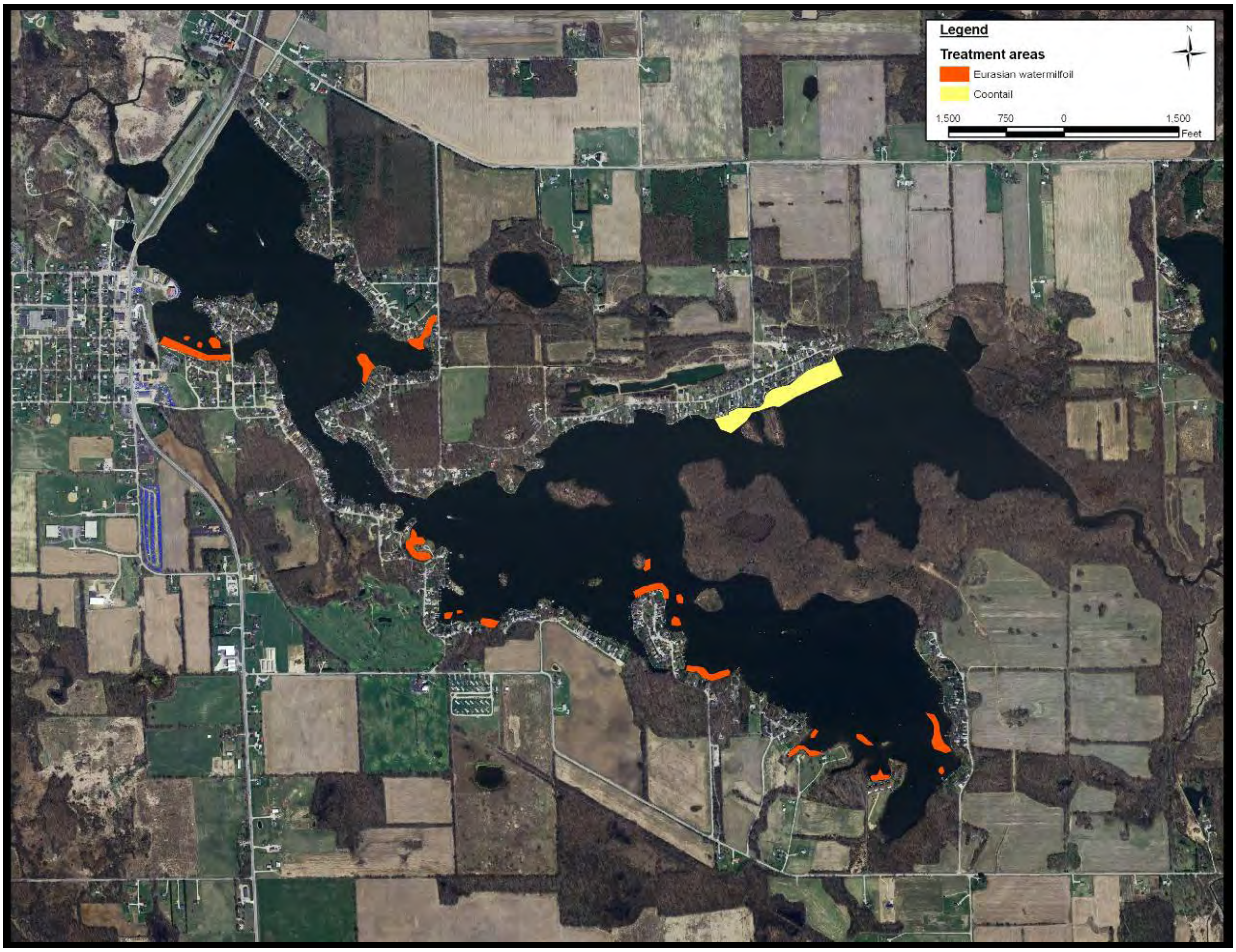


Figure 11. Eurasian watermilfoil and coontail treatment areas located on Sylvan Lake. Weed Patrol completed treatment for Eurasian watermilfoil on June 25, 2007 and treated for coontail on August 6, 2007.

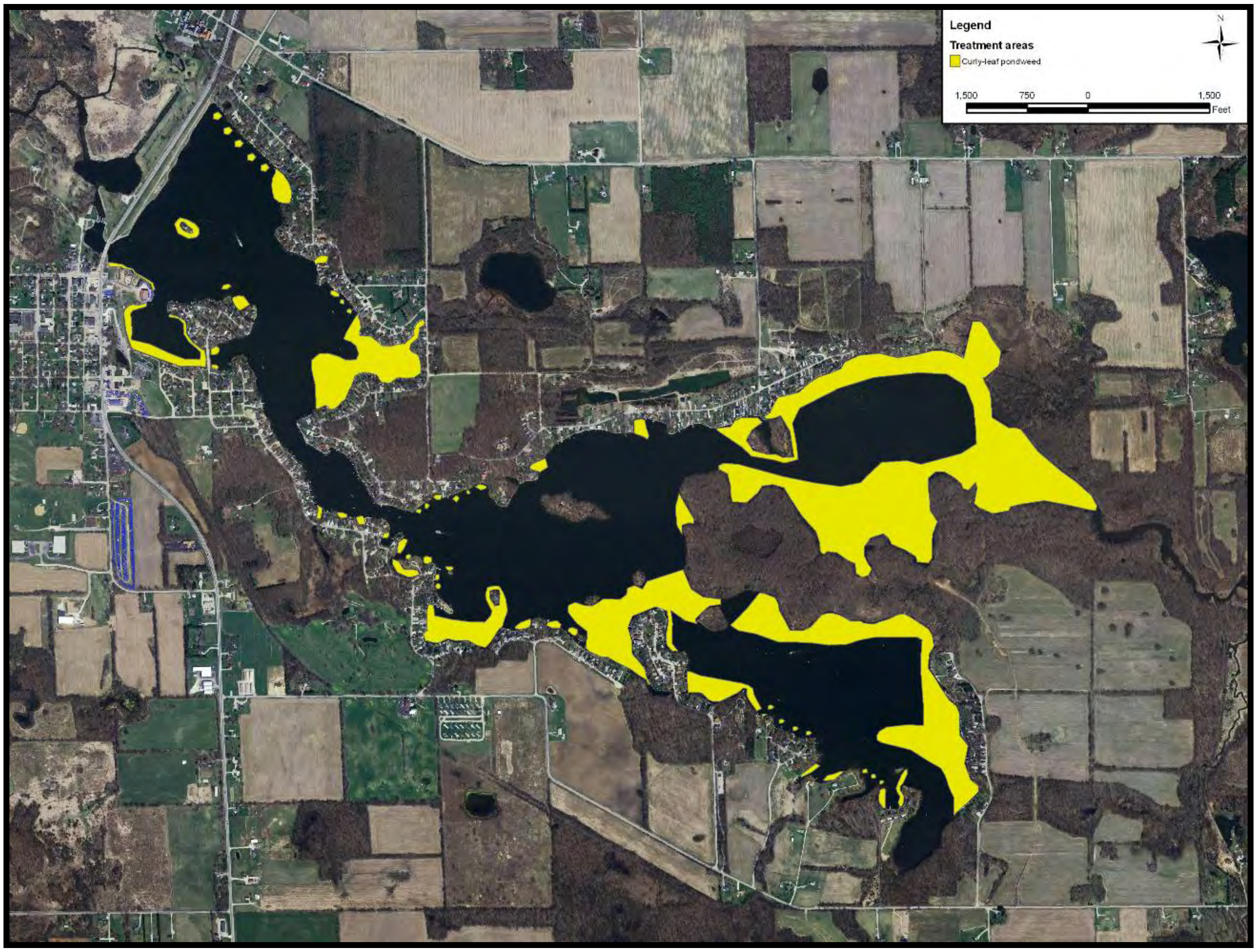


Figure 12. Curly-leaf pondweed treatment areas located on Sylvan Lake. Weed Patrol completed treatment on May 8, 2007.

8.0 Aquatic Plant Community Characterization

8.1 Methods

JFNew surveyed Sylvan Lake's plant community on May 30 and July 30, 2007 according to the Indiana Department of Natural Resources sampling protocols (IDNR, 2007). JFNew examined the entire littoral zone of the lake during each of the two assessments. Surveys were completed using the Tier II survey protocol updated by the IDNR LARE staff in May 2007 (IDNR, 2007). The survey protocol generally follows previous Tier II protocols and is most similar to the 2006 protocol, which requires that the sampling points be stratified over the entire depth of the lake's littoral zone. Total points sampled per stratum were determined as follows:

1. Appendix D of the survey protocol was consulted to determine the number of points to be sampled and the maximum sampling depth. This determination was based on the lake size (surface area) and trophic status.
2. Table 3 of the survey protocol was referenced as an indicator of the number of sample points per stratum. Table 5 in this report lists the sampling strategy for Sylvan Lake.

Stratum refers to depth at which plants were observed. Dominance presented in subsequent tables was calculated by the IDNR protocol. The frequency per species presented in subsequent tables provides a measure of the frequency of a species in each stratum.

Table 5. Tier II sampling strategy for Sylvan Lake using the 2007 Tier II protocol.

Lake	Size	Trophic Status	Number of Points	Stratification of Points
Sylvan	669 acres	Mesotrophic	90	29 pts 0-5 foot stratum 27 pts 5-10 foot stratum 24 pts 10-15 foot stratum 10 pts 15-20 ft stratum

The data from the surveys are used to calculate different lake characteristics and community and species metrics. The different characteristics and metrics calculated from the Tier II method are defined below:

- Littoral depth: Maximum depth that aquatic vegetation is present.
- Total sites: Total number of sites sampled.
- Littoral sites: Number of sites within the littoral depth.
- Secchi depth: Measurement of the transparency of water.
- Species richness: count of all submersed plant species collected.
- Native species richness: count of all native submersed plant species collected.
- Maximum number of species per site: highest number of species collected at any site.
- Mean number of species per site: The average number of all species collected per site.
- Mean number of native species per site: The average number of native species per site.
- Species diversity index: Modified Simpson's diversity index—a measure that provides a means of comparing plant community structure and stability over time.
- Frequency of occurrence: Measurement of the percentage of sampled sites where each species is present.
- Relative frequency of occurrence: Measures the distribution of plants occurrence throughout the lake in relation to each other.

- Dominance index: Combines the frequency of occurrence and relative density into a dominance value. This value characterizes how dominant a species is within the aquatic plant community (IDNR, 2007).

8.2 2007 Sampling Results

Spring (May) and summer (July) exotic species surveys and spring and summer Tier II surveys were completed on Sylvan Lake in 2007 by JFNew. An additional survey of the coontail community was completed on August 16, 2007. The survey schedule is detailed in Table 6. No samples were sent to an outside taxonomist for vouchering or identification.

Table 6. Survey schedule for pre-treatment and Tier II surveys.

Survey	Date
Spring exotic species survey	June 4, 2007
Summer exotic species survey	July 26, 2007
Spring Tier II -Spring	June 4, 2007
Summer Tier II -Summer	July 26, 2007
Coontail community mapping	August 16, 2007

8.2.1 Exotic Species Mapping

Exotic species locations are detailed in Figure 13. Additional plant community information is discussed in detail in the following sections.

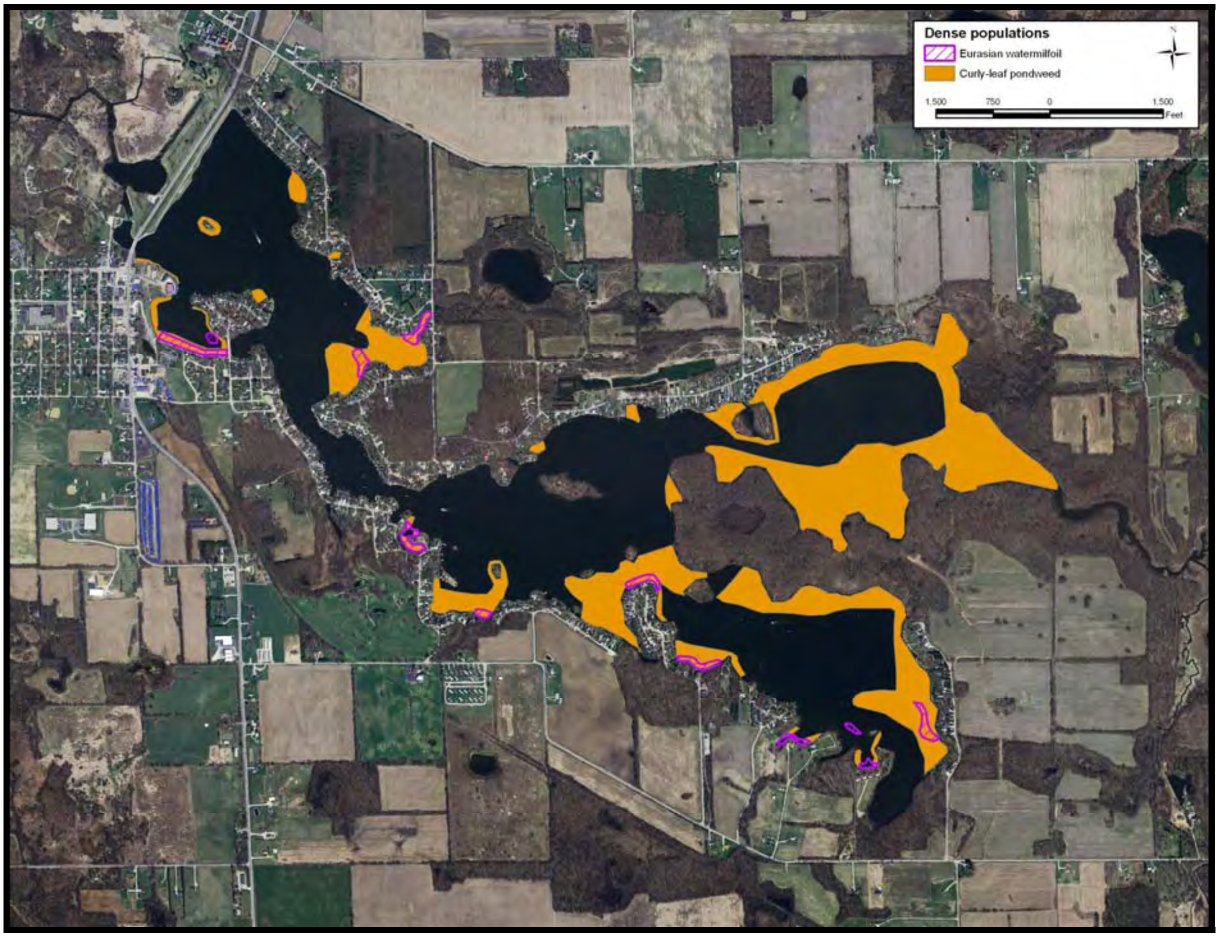


Figure 13. Dense curly-leaf pondweed and Eurasian watermilfoil locations identified within Sylvan Lake during the 2007 assessments.

Spring Assessment

The dominant plant species found in Sylvan Lake include coontail, curly-leaf pondweed, and filamentous algae (Table 7). One state rare species, horned pondweed (*Zannichellia palustris*) was identified during the spring assessment. Locations of this species are displayed in Figure 14. There are a number of problem areas located throughout the lake. Eurasian watermilfoil was identified at very few sampling points and was not a problem at these sites during the spring survey. However, Eurasian watermilfoil populations growing along narrow, shallow shelves were identified as a problem during the spring survey. Even though surveys were not conducted at the peak of curly-leaf pondweed growth, there were numerous areas where it was identified in Sylvan Lake during the spring survey (Figure 13). Based on survey points, curly-leaf pondweed was found in rather low densities, but was dispersed evenly throughout the lake. However, curly-leaf pondweed density and distribution was observed to be higher in the headwaters of the lake (Pit Lake and the Upper Basin). To adequately assess the density of curly-leaf pondweed, an assessment should be conducted in

April or early May to adequately quantify the presence and location of curly-leaf pondweed within Sylvan Lake.

Table 7. Aquatic plant species observed in Sylvan Lake during the spring and summer surveys completed June 4 and July 26, 2007.

Scientific Name	Common Name	Stratum	Spring	Summer
Asclepias incarnata	Swamp milkweed	Emergent		X
Ceratophyllum demersum	Coontail	Submergent	X	X
Chara species	Chara species	Submergent	X	X
Decodon verticillatus	Whirled loosestrife	Emergent	X	X
Elodea canadensis	Common water weed	Submergent	X	X
Filamentous algae	Filamentous algae	Algae	X	X
Hibiscus species	Hibiscus species	Emergent	X	X
Lemna minor	Common duckweed	Floating	X	X
Lemna trisulca	Star duckweed	Floating		X
Lythrum salicaria	Purple loosestrife	Emergent	X	X
Myriophyllum exalbescens	Northern watermilfoil	Submergent	X	X
Myriophyllum spicatum	Eurasian watermilfoil	Submergent	X	X
Najas flexilis	Slender naiad	Submergent	X	X
Najas guadalupensis	Southern naiad	Submergent	X	X
Nelumbo lutea	American lotus	Floating	X	X
Nuphar advena	Spatterdock	Floating	X	X
Nymphaea tuberosa	White water lily	Floating	X	X
Phalaris arundinacea	Reed canary grass	Emergent	X	X
Potamogeton crispus	Curly-leaf pondweed	Submergent	X	X
Potamogeton gramineus	Grassy pondweed	Submergent	X	X
Potamogeton zosteriformis	Flat-stem pondweed	Submergent	X	
Spirodela polyrhiza	Large duckweed	Floating		X
Stuckenia pectinatus	Sago pondweed	Submergent	X	X
Typha latifolia	Broad-leafed cattail	Emergent	X	X
Vallisneria americana	Eel grass	Submergent	X	
*Zannichellia palustris**	Horned pondweed	Submergent	X	

*State rare species

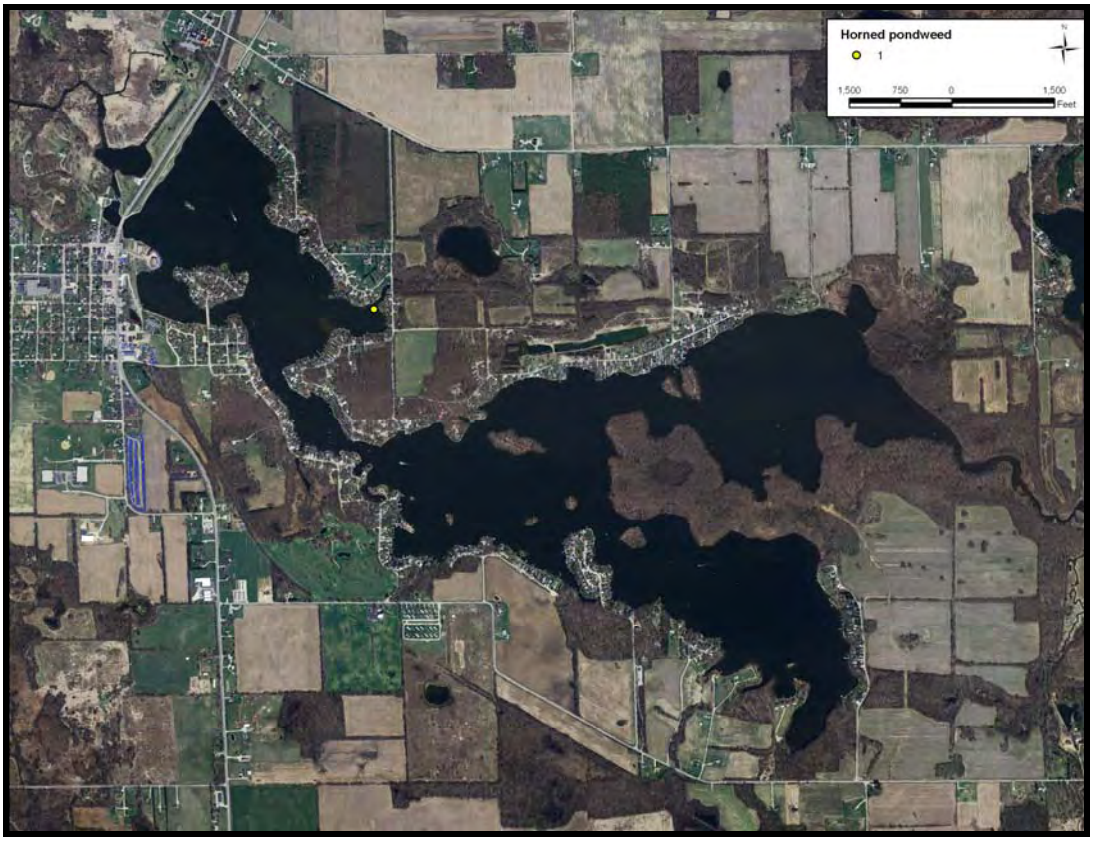


Figure 14. Horned pondweed (state rare species) locations and dominance as surveyed June 4, 2007.

Summer Assessment

There were no additional plant species identified during the summer survey, but a few from the spring survey were not found. Those not found in the summer include eel grass, flat-stem pondweed, and horned pondweed. Eurasian watermilfoil frequency increased from spring to summer and was found in more locations than those identified during the spring survey. Dense areas of Eurasian watermilfoil were identified along the southern shoreline and in small areas along the northern shoreline of Sylvan Lake. Curly-leaf pondweed was found in fewer locations and at lower frequency during the summery survey.

8.2.2 Tier II

Two Tier II surveys were completed in order to document changes in the plant community resulting from the aquatic herbicide treatment. The Tier II surveys were completed on June 4, 2007 (pre-treatment) and on July 26, 2007 (post-treatment). Raw data is included in Appendix B. Transparency was measured using a Secchi disk prior to both sampling events. Transparency was found to be 8.2 feet in the spring and was estimated at 6 feet during the summer survey. Due to unfavorable weather conditions, an accurate reading could not be obtained during the summer survey. Based on the survey protocol, plants were sampled to a depth of 20 feet. However, plants were only present to a maximum depth of 16 feet during the spring, pre-treatment survey and to a depth of 14 feet during the summer, post-treatment survey. Ninety sites were randomly selected within the littoral zone based on the stratification indicated in the protocol. Results of the sampling are detailed in Appendix C.

During the pre-treatment survey, coontail dominated the plant community over all depths (0-20 feet; Table 8). This species was found at the highest percentage of sites throughout the entire sampled water column (47%) and also had the highest relative density. Throughout the entire sampled water column, filamentous algae and curly-leaf pondweed were relatively frequent and were found at 53% and 30% of the sites, respectively (Table 8). Coontail, filamentous algae, and curly-leaf pondweed dominated Sylvan Lake in the 0-5, 5-10, and 10-15 foot strata (Appendix C; spring). Coontail maintained the highest frequencies for the top three strata and was equally frequent with curly-leaf pondweed and common elodea in the deepest stratum (15-20 feet). Frequencies of coontail decreased with increasing depth with coontail occurring at 75%, 44%, 41%, and 10% of the sites in the 0-5, 5-10, 10-15, and 15-20 foot strata. Dominance also decreased from a high of 35 in the 0-5 foot stratum to 13.3 at 5-10 feet, 10 at the 10-15 foot stratum, and 2 in the 15-20 foot stratum. Curly-leaf pondweed frequencies and dominances followed similar patterns; however, the highest frequency and dominance occurred in the 5-10 foot stratum measuring 41% and 8.2, respectively. Frequency and dominance of curly-leaf pondweed declined in the deeper strata where curly-leaf pondweed was ultimately co-dominant and co-frequent with coontail and common elodea and were the only species identified in the 15-20 foot stratum. Eurasian watermilfoil was found in relatively low frequency and dominance throughout the water column. Figures 15 to 17 document sampling locations (Figure 15) and sites where Eurasian watermilfoil (Figure 16) and curly-leaf pondweed (Figure 17) were identified during the pre-treatment survey.

Table 8. Spring (pre-treatment) Tier II survey metrics and results for entire lake strata as collected June 4, 2007.

Occurrence and abundance of submersed aquatic plants in Sylvan Lake.					
Total Sites:	81	Mean species / site:	1.25	Native diversity:	0.70
Littoral Sites:	74	Maximum species / site:	7	Species diversity:	0.78
Littoral Depth (ft):	16	Number of species:	13	SE Mean natives / site:	0.12
Date:	6/4/07	Littoral sites with plants:	51	Mean natives / site:	0.90
Lake:	Sylvan	Secchi(ft):	8.2	SE Mean species / site:	0.15

All depths (0-20')		**Frequency of Occurrence**	**Frequency per Species**				
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	46.91	53.09	35.80	4.94	6.17	16.30
Potamogeton crispus	Curly-leaf pondweed	29.63	70.37	27.16	2.47	0.00	6.91
Zannichellia palustris	Horned pondweed	6.17	93.83	4.94	0.00	1.23	2.22
Potamogeton gramineus	Grassy pondweed	8.64	91.36	8.64	0.00	0.00	1.73
Najas guadalupensis	Southern naiad	8.64	91.36	8.64	0.00	0.00	1.73
Myriophyllum spicatum	Eurasian watermilfoil	4.94	95.06	3.70	1.23	0.00	1.48
Elodea canadensis	Common water weed	3.70	96.30	2.47	1.23	0.00	1.23
Chara species	Chara species	4.94	95.06	4.94	0.00	0.00	0.99
Vallisneria americana	Eel grass	3.70	96.30	3.70	0.00	0.00	0.74
Potamogeton zosteriformis	Flat-stem pondweed	2.47	97.53	2.47	0.00	0.00	0.49
Myriophyllum exalbescens	Northern watermilfoil	2.47	97.53	2.47	0.00	0.00	0.49
Potamogeton pectinatus	Sago pondweed	1.23	98.77	1.23	0.00	0.00	0.25
Najas flexilis	Slender naiad	1.23	98.77	1.23	0.00	0.00	0.25
Filamentous algae	Filamentous algae	53.09					

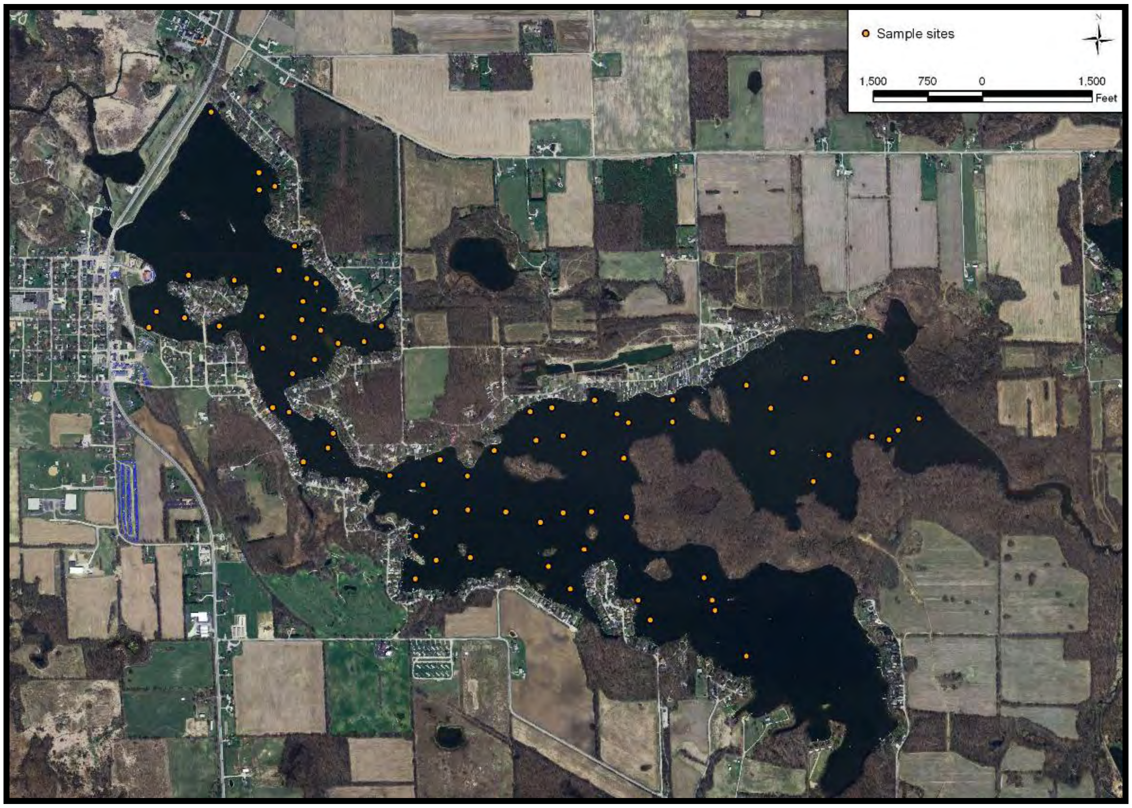


Figure 15. Sampling locations for the Sylvan Lake spring Tier II survey, June 4, 2007.

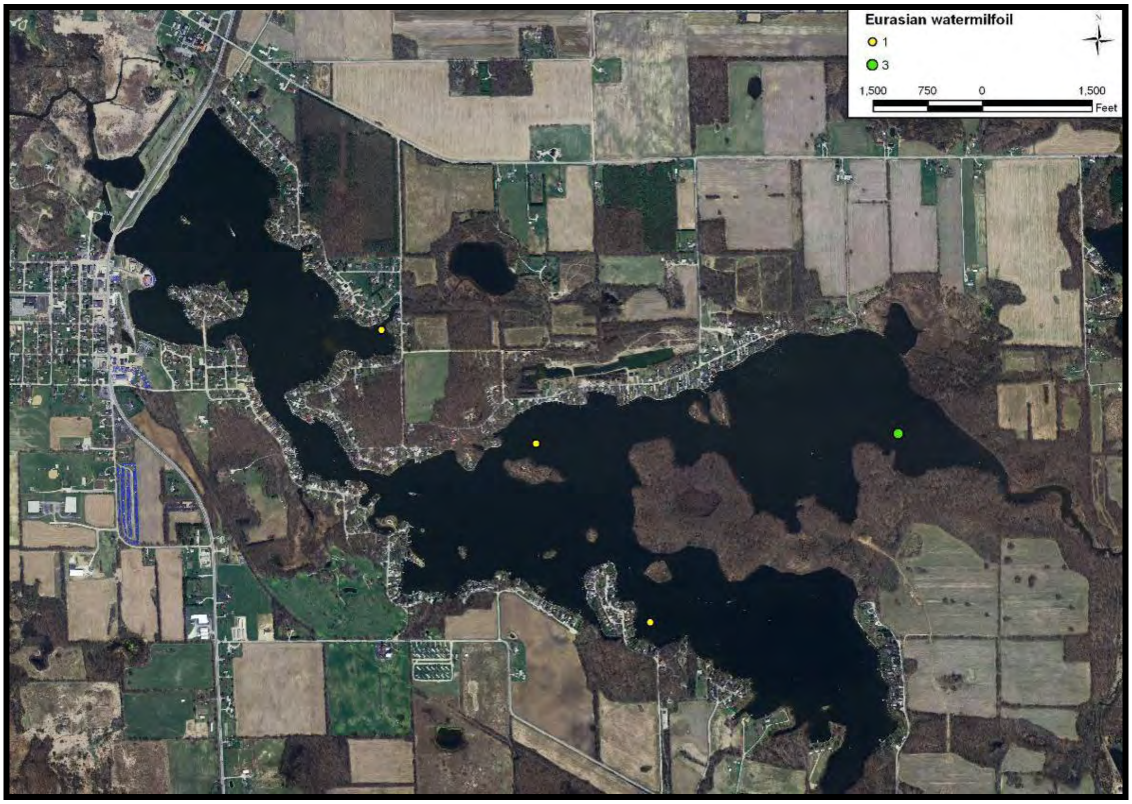


Figure 16. Eurasian watermilfoil locations and densities as surveyed June 4, 2007.

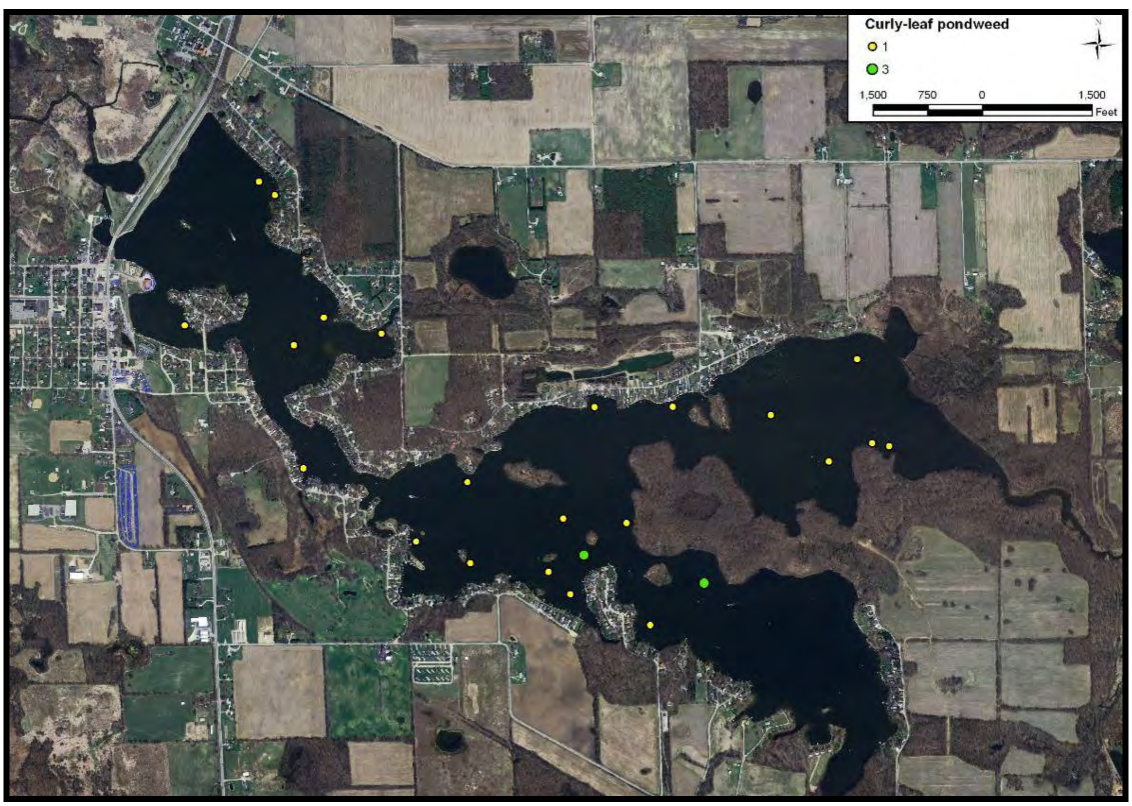


Figure 17. Curly-leaf pondweed locations and densities as surveyed June 4, 2007.

Following treatment, coontail and filamentous algae were still the most abundant species in Sylvan Lake (Table 9). Coontail was present at 56% of the sample sites and had the greatest relative and mean densities throughout the entire sampled water column and in each of the three strata (0-5 feet, 5-10 feet and 10-15 feet). Throughout the entire sampled water column, filamentous algae, Eurasian watermilfoil, and chara were relatively frequent and were found at 31%, 30%, and 28% of the sites, respectively (Appendix C; summer). Coontail dominated the shallowest strata (0-5 feet) and was identified at 84% of the sites in this stratum. Coontail also possessed the highest dominance (47.2) and was nearly twice as dominant as any other species in this stratum. Chara, southern naiad, filamentous algae, Eurasian watermilfoil, and grassy pondweed were also prevalent in the 0-5 foot stratum and were present at 52%, 48%, 48%, 44%, and 28% of the sites, respectively. The frequency and dominance of all species decreased with depth. Filamentous algae and coontail were the only species identified in the deepest stratum (10-15 feet). Eurasian watermilfoil was found at more sites during the post-treatment survey (30% compared to 5% during pre-treatment) and had a higher relative and mean density than that present during the pre-treatment survey. Conversely, curly-leaf pondweed was identified at only 11% of the sites during the post treatment survey compared to 30% of the sites during the pre-treatment survey. Figures 18 to 20 detail plant sampling locations (Figure 18) and the locations where Eurasian watermilfoil (Figure 19) and curly-leaf pondweed (Figure 20) were identified during the post-treatment surveys.

Table 9. Summer (post-treatment) Tier II survey metrics and results for entire lake strata as collected July 26, 2007.

Occurrence and abundance of submersed aquatic plants in Sylvan Lake.					
Total Sites:	90	Mean species / site:	1.79	Native diversity:	0.76
Littoral Sites:	80	Maximum species / site:	6	Species diversity:	0.83
Littoral Depth (ft):	14	Number of species:	10	SE Mean natives / site:	0.16
Date:	7/26/07	Littoral sites with plants:	56	Mean natives / site:	1.38
Lake:	Sylvan	Secchi(ft):	6.0	SE Mean species / site:	0.20

All depths (0-20')		**Frequency of Occurrence**	**Frequency per Species**				
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	55.56	44.44	26.67	11.11	17.78	29.78
Myriophyllum spicatum	Eurasian watermilfoil	30.00	71.11	22.22	5.56	1.11	16.22
Chara species	Chara species	27.78	72.22	21.11	4.44	2.22	9.11
Potamogeton gramineus	Grassy pondweed	16.67	83.33	14.44	0.00	2.22	5.11
Najas guadalupensis	Southern naiad	16.67	83.33	13.33	2.22	1.11	5.11
Elodea canadensis	Common water weed	7.78	92.22	4.44	3.33	0.00	2.89
Potamogeton pectinatus	Sago pondweed	7.78	92.22	5.56	2.22	0.00	2.44
Potamogeton crispus	Curly-leaf pondweed	11.11	88.89	11.11	0.00	0.00	2.22
Najas flexilis	Slender naiad	3.33	96.67	2.22	1.11	0.00	1.11
Myriophyllum exalbescens	Northern watermilfoil	2.22	97.78	2.22	0.00	0.00	0.44
Filamentous algae	Filamentous algae	31.11					

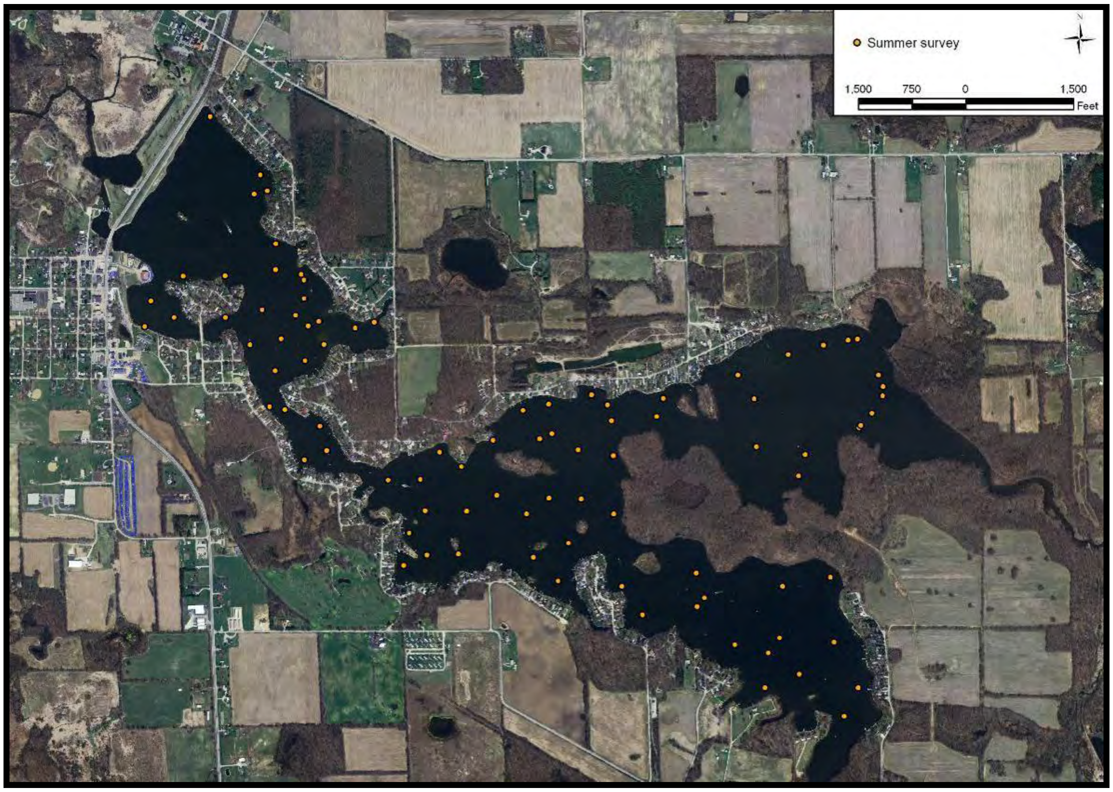


Figure 18. Sampling locations for the Sylvan Lake summer Tier II survey, July 26, 2007.

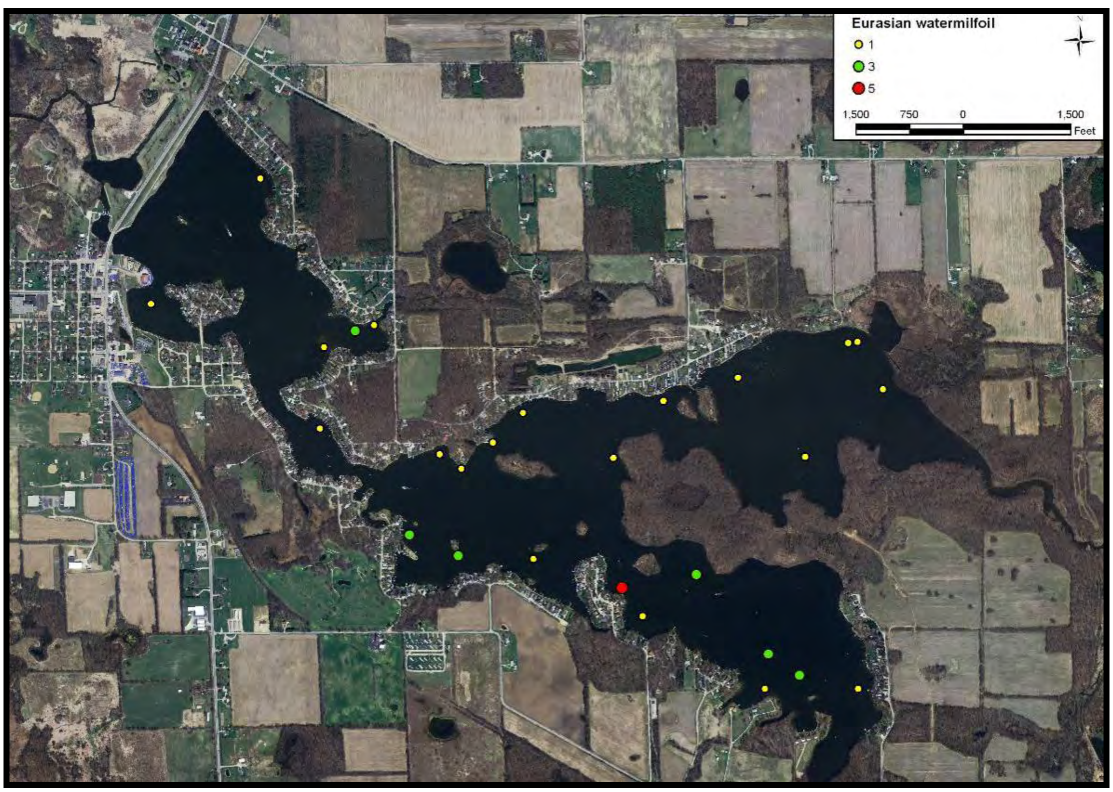


Figure 19. Eurasian watermilfoil locations and densities as surveyed July 26, 2007.

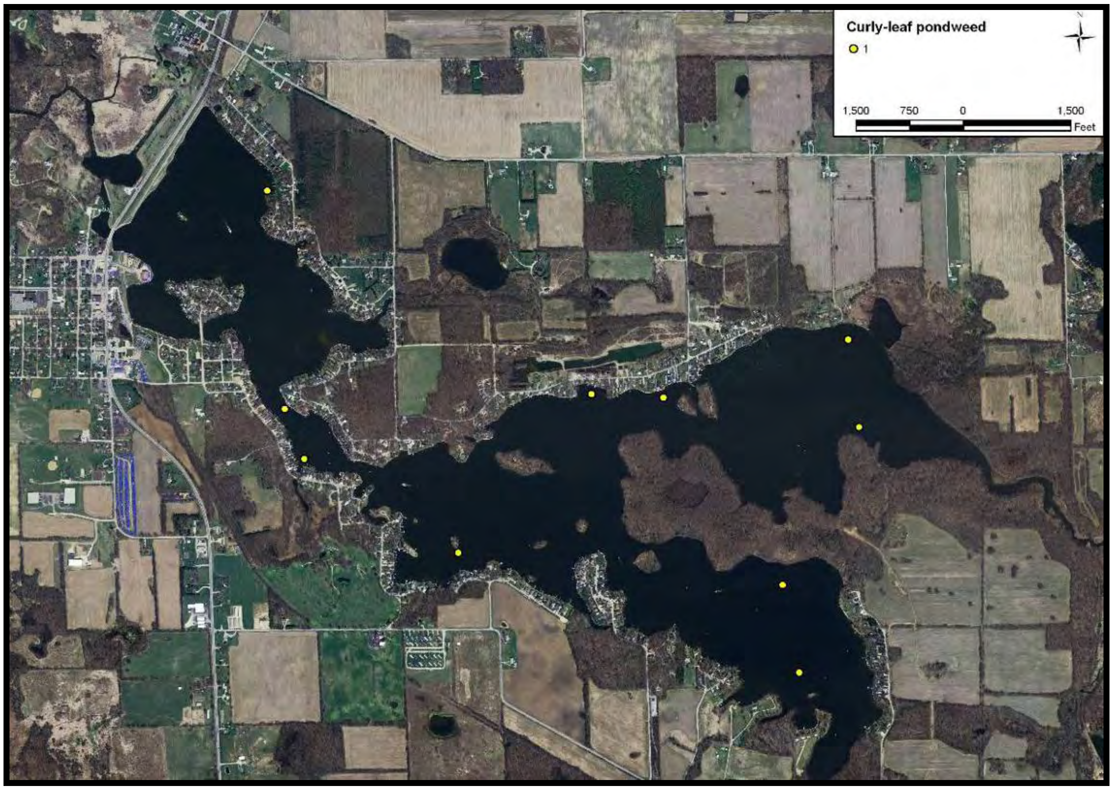


Figure 20. Curly-leaf pondweed locations and densities as surveyed July 26, 2007.

When recently collected data is compared with data reported by Pearson (2004), Sylvan Lake possessed greater diversity than the lakes surveyed by Pearson (Table 10). Sylvan Lake possessed 13 and 10 species during the pre- and post-treatment surveys, while Pearson collected only eight species on average. This year's results indicate the highest diversity recorded during aquatic plant surveys of Sylvan Lake. Sylvan Lake also possessed more native species (11 and 8 compared to Pearson's 7) and greater rake diversity (1.25 and 1.79 for pre- and post-treatment, respectively compared with 0.62 by Pearson) than that recorded during Pearson's survey.

Table 10. A comparison of the aquatic plant community in Sylvan Lake with the average values for plant community metrics found by Pearson (2004) in his survey of 21 northern Indiana lakes.

	June 2003	July 2003	May 2005	July 2005	June 2007	July 2007	Indiana Average (2004)
Percentage of littoral sites containing plants	-	-	70%	73%	69%	70%	-
Number of species collected	5	10	3	5	13	10	8
Number of native species collected	3	8	1	3	11	8	7
Species Richness (Average # species/site)	1.46	1.41	-	-	1.25	1.79	1.61
Native Species Richness	0.76	1.23	0.08	0.74	0.90	1.38	1.33
Rake Diversity (SDI)	0.66	0.62	0.86	1.06	0.78	0.83	0.62
Native Rake Diversity (SDI)	0.16	0.51	0.08	0.88	0.70	0.76	0.5

Aquatic Vegetation Sampling Discussion

The primary focus of an aquatic vegetation management plan is to document changes within the aquatic plant community pre- and post-treatment and to develop plans for future work. Eurasian watermilfoil and curly-leaf pondweed were the two exotic species targeted in the herbicide treatment that occurred on June 25, 2007. Sylvan Lake underwent a decrease in both the relative density and site abundance of curly-leaf pondweed. However, the true impact of the treatment on curly-leaf pondweed populations remains elusive as curly-leaf pondweed density naturally declines in the summer due to increased water temperatures. The treatment of Eurasian watermilfoil did not visibly impact the Eurasian watermilfoil community within Sylvan Lake. Rather, the relative density and site frequency of Eurasian watermilfoil increased from the spring to the summer in Sylvan Lake. This could be due to a number of factors where the two most likely explanations are as follows: 1) very few of the sampling points were located within the specific beds where herbicide applications for Eurasian watermilfoil were located and 2) Eurasian watermilfoil generally increases in density during the summer; therefore, the observed increase in density and frequency is due to this species' natural growth pattern.

The effects of the treatment on the native aquatic plant community are unclear. Comparing the 2007 spring and summer Tier II survey metrics indicates that the quality of the native aquatic plant community in Sylvan Lake increased following treatment. The native rake diversity (SDI), native species richness, and site species native diversity all increased following treatment. However, the number of native plant species found in Sylvan Lake decreased from 11 to 8 from the spring to the summer surveys. The first three factors suggest an improvement in the native plant community following treatment while the latter suggests declines in the native community. Of the species that were present during the pre-treatment survey that were not present during the post-treatment survey, one is a cool water species that typically is not present during periods of warmer water while the other two species occurred in relatively low frequency (<3%) and could have been present but were not sampled during the summer survey. Additionally, one variable, which may be masking the true effect of the herbicide application, is the seasonal variation in plant biomass as the Tier II survey conducted by JFNew occurred in late July, which is the expected time of peak seasonal biomass (Pearson, 2004). Other temporal variables that may impact plant bed composition include increased boat traffic, predation, and physical stressors such as increased temperatures as the season progressed. Additionally, natural variations of the plant community throughout the littoral zone may also explain the initial decline as the IDNR used different survey points than those used by JFNew.

8.3 Aquatic Plant Inventory Discussion

Since we cannot account for all the spatial variables impacting the plant community, such as boat-traffic and changes in nutrient availability, or for temporal variables like climactic conditions, including temperature and precipitation levels, an exact and precise analysis regarding the impact of herbicide treatment upon Sylvan Lake's aquatic plant community is not possible. Still, general trends emerge from the data that are useful for the purpose of management decisions. When comparing data for Eurasian watermilfoil, site frequencies, mean and relative densities, and dominance, all appear to decrease for spring survey data. This suggests that Eurasian watermilfoil populations are declining on an annual basis. However, summer survey data does not support this trend. Site frequencies, mean densities, and dominance scores calculated for summer survey data increased during each survey. This suggests that the Eurasian watermilfoil population is increasing in both density and distribution (Table 11).

Table 11. Variation in site frequency, relative and mean density, and dominance of Eurasian watermilfoil and curly-leaf pondweed within Sylvan Lake from 2003 to 2007. Spring data is in bold.

Common Name	Date	Site Frequency	Relative Density	Mean Density	Dominance
Eurasian watermilfoil	**6/2/03**	**28.6**	**0.63**	**2.21**	**12.7**
	7/23/03	9.7	0.15	1.47	3.0
	5/10/05	**12.4**	**0.20**	**1.21**	**1.7**
	7/27/05	13.5	0.30	2.29	3.0
	6/4/07	**4.9**	**0.07**	**1.50**	**1.5**
	7/26/07	30.0	0.48	1.59	9.6
Curly-leaf pondweed	**6/2/03**	**44.9**	**1.48**	**2.33**	**21.0**
	7/23/03	8.2	0.83	1.00	1.6
	5/10/05	**94.3**	**3.40**	**3.60**	**4.5**
	7/27/05	2.9	0.10	2.00	1.0
	6/4/07	**29.6**	**0.35**	**1.17**	**6.9**
	7/26/07	11.1	0.11	1.00	2.2

When comparing curly-leaf pondweed data, a decline in frequency, density, and distribution is suggested. However, a closer look at the data indicates that the population may be more cyclical in nature. Spring survey data from 2003, 2005, and 2007 indicates that an increase in frequency, relative and mean density, and dominance occurred from 2003 to 2005. This was followed by a decline in frequency and mean and relative density from 2005 to 2007. However, the dominance of curly-leaf pondweed increased from 2005 to 2007. An opposite pattern emerges when summer curly-leaf pondweed data are reviewed. Summer data indicate that curly-leaf pondweed decreased in frequency, mean and relative density, and dominance from 2003 to 2005. However, increases in frequency, mean density, and dominance occurred from 2005 to 2007. This suggests that herbicide application may have little effect on the growth of curly-leaf pondweed during the summer. The growth pattern of curly-leaf pondweed further supports this hypothesis. Curly-leaf pondweed typically grows in cooler water and dies back as water temperatures increase. If applied at the correct time, when water temperatures are low and turions have not yet formed, the application of herbicide limits the growth of curly-leaf pondweed and the formation of turions. If this occurs routinely each year, the overall production of curly-leaf pondweed should decrease. However, this does not appear to be the case in Sylvan Lake. The density and distribution of curly-leaf pondweed appears to be decreasing during the spring surveys conducted on the lake. Conversely, summer production of curly-leaf pondweed appears to be increasing. This would suggest that the timing of herbicide application may be incorrect or that previously produced turions have traveled to new areas of the lake which are not currently being treated for curly-leaf pondweed.

Finally, it is difficult to determine how the native aquatic plant communities within Sylvan Lake are responding to herbicide treatment as only six data sets spanning three growing seasons have been collected. Furthermore, these data sets are separated by one growing season each. A more complete data set should allow for better determination of the plant community's response to treatment methodologies in Sylvan Lake.

9.0 Aquatic Vegetation Management Alternatives

A good aquatic plant management plan includes a variety of management techniques applicable to different parts of a lake depending on the lake's water quality, the characteristics of the plant community in different parts of the lake, and lake users' goals for different parts of the lake. Many aquatic plant management techniques, including chemical control, harvesting, and biological control, require a permit from the IDNR. Depending on the size and location of the treatment area, even individual residents may need a permit to conduct a treatment. Residents should contact the IDNR Division of Fish and Wildlife before conducting any treatment.

The following paragraphs describe some aquatic plant management techniques that may be applicable to Sylvan Lake, given its specific ecological condition. The alternatives that will be discussed include no action, institutional protection, environmental manipulation, nutrient reduction, mechanical harvesting, bottom covers, biological control, chemical control, and preventive measures.

9.1 No Action

Herbicide applications have been used long-term at Sylvan Lake to control Eurasian watermilfoil and curly-leaf pondweed. With no change in treatment type or methodology, these treatments will likely continue. However, the no action alternative really targets the idea that no treatment will occur. Without any treatment, exotic species will continue to grow unchecked throughout Sylvan Lake resulting in a species population that is at a minimum the same size or larger than that observed during the 2007 surveys. This will likely result in a decrease in native plant density and diversity, the formation of a monoculture of exotic species, and a loss of any high quality species that may be present in Sylvan Lake. Additionally, the growth of these nuisance species could increase nutrient cycling within Sylvan Lake thereby making more nutrients available to plants and algae ultimately resulting in a decline in the lake's water quality. This would likely eventually result in reduced access for shoreline and offshore users and overall limit recreational access.

9.2 Institutional Protection of Beneficial Vegetation

Invasive species often colonize disturbed areas first before moving to other areas of the lake. The protection of native and/or beneficial aquatic vegetation can prevent the growth of exotic or nuisance species. This can be accomplished in two ways: limiting user impacts to beneficial plants due to boating or recreational uses and not over-treating beneficial plant beds. Users can restrict the use of specific areas of Sylvan Lake through the use of buoys or the establishment of user zones. The second methodology, over-treating of native plant beds, could be a concern in Sylvan Lake in the future. This issue occurs when a beneficial, native plant bed is deemed to be a nuisance and treatment of this area begins. Once the native plant community is weakened through treatment, exotic species can move into these areas colonizing open sediment. Once a foothold is established, the aggressive, exotic species can then out-compete native varieties. As aquatic plant treatment at Sylvan Lake has occurred on a large-scale historically, this may have been an issue in the past and could continue to be an issue in the future. The Sylvan Lake Improvement Association should be aware of this issue and tailor their treatment efforts to not impact beneficial native species.

9.3 Environmental Manipulation/Water Level Manipulation

Environmental manipulation often refers to manipulating the lake's water level to control vegetation. This occurs by raising water levels resulting in drowning the plants or lowering the water level to freeze or heat the aquatic plant community. This type of treatment is limited to lakes where water levels are easily manipulated. Water level manipulation can be effective at controlling exotic or invasive species in Sylvan Lake; however, this treatment will be no more or less effective for exotic or invasive native species. Additionally, exotic or invasive species may colonize newly exposed substrate resulting from water level manipulation. Sylvan Lake's water control structure does not offer ease of water-level manipulation. However, this has occurred in the past when dam repair was completed and therefore, could be used again in the future.

9.4 Nutrient Reduction

Like terrestrial vegetation, aquatic vegetation has several habitat requirements that need to be satisfied in order for the plants to grow or thrive. Aquatic plants depend on sunlight as an energy source. The amount of sunlight available to plants decreases with depth of water as algae, sediment, and other suspended particles block light penetration. Consequently, most aquatic plants are limited to maximum water depths of approximately 10-15 feet (3-4.5 m), but some species, such as Eurasian watermilfoil, have a greater tolerance for lower light levels and can grow in water deeper than 32 feet (10 m) (Aikens et al., 1979). Hydrostatic pressure rather than light often limits plant growth at deeper water depths (15-20 feet or 4.5-6 m).

Water clarity affects the ability of sunlight to reach plants, even those rooted in shallow water. Lakes with clearer water have an increased potential for plant growth. Sylvan Lake possesses moderately better water clarity than the average Indiana lake. The Secchi disk depth measured during the plant survey was 8.6 feet in the spring and was estimated to be 6 feet in the summer. As a general rule of thumb, rooted plant growth is restricted to the portion of the lake where water depth is less than or equal to 2 to 3 times the lake's Secchi disk depth. This does not hold true in Sylvan Lake, where rooted plants were observed in water to a depth of approximately 14 feet, which is slightly less than two times the lake's average Secchi disk depth.

Aquatic plants also require a steady source of nutrients for survival. Many aquatic plants, also known as aquatic macrophytes, differ from microscopic algae (which are also plants) in their uptake of nutrients. Aquatic macrophytes receive most of their nutrients from the sediments via their root systems rather than directly utilizing nutrients in the surrounding water column. Some competition with algae for nutrients in the water column does occur. The amount of nutrients taken from the water column varies for each macrophyte species. Because macrophytes obtain most of their nutrients from the sediments, lakes, which receive high watershed inputs of nutrients to the water column, will not necessarily have aquatic macrophyte problems. However, lakes with large sources of readily-available nutrients (phosphorus and nitrogen), typically contain higher density aquatic plant communities. Reductions in nutrients can both increase and decrease aquatic plant density. Increases in plant density occur due to improved water clarity, which often results in more plant growth. Sylvan Lake contains relatively high nutrient levels and therefore would be expected to contain a high density aquatic plant community. However, moderate light penetration and a reservoir of nutrients provide a relatively dense and very diverse community. The reduction of nutrient inputs to Sylvan Lake will likely not alter the aquatic plant community as a whole. Rather, localized effects of the nutrient reduction will likely occur in the areas of the lake closest to the change in nutrient resources.

9.5 Mechanical Harvesting

Harvesting involves the physical removal of vegetation from lakes. Harvesting should also be viewed as a short-term management strategy. Like chemical control, harvesting needs to be repeated yearly and sometimes several times within the same year. (Some carry-over from the previous year has occurred in certain lakes.) Despite this, harvesting is often an attractive management technique because it can provide lake users with immediate access to areas and activities that have been affected by excessive plant growth. Mechanical harvesting is also beneficial in situations where removal of plant biomass will improve a lake's water chemistry. (Chemical control leaves dead plant biomass in the lake to decay and consume valuable oxygen.)

Macrophyte response to harvesting often depends upon the species of plant and particular way in which the management technique is performed. Pondweeds, which rely on sexual reproduction for propagation, can be managed successfully through harvesting. However, many harvested plants, especially milfoil, can re-root or reproduce vegetatively from the cut pieces left in the water. Plants harvested several times during the growing season, especially late in the season, often grow more slowly the following season (Cooke et al., 1993). Harvesting plants at their roots is usually more effective than harvesting higher up on their stems (Olem and Flock, 1990). This is especially true with Eurasian watermilfoil and curly-leaf pondweed. Benefits are also derived if the cut plants and the nutrients they contain are removed from the lake. Harvested vegetation that is cut and left in the lake ultimately decomposes, contributing nutrients and consuming oxygen.

Hand harvesting may be the most economical means of harvesting on Sylvan Lake. Hand harvesting is recommended in small areas where human uses are hampered by extensive growths (docks, piers, beaches, boat ramps). In these small areas, plants can be efficiently cut and removed from the lake with hand cutters such as the Aqua Weed Cutter (Figure 21). In less than one hour every 2-3 weeks, a homeowner can harvest 'weeds' from along docks and piers. Depending on the model, hand-harvesting equipment for smaller areas cost from $50 to $1500 (McComas, 1993). To reduce the cost, several homeowners can invest together in such a cutter. Alternatively, a lake association may purchase one for its members. This sharing has worked on other Indiana lakes with aquatic plant problems. Use of a hand harvester is more efficient and quick-acting, and less toxic for small areas than spot herbicide treatments. Hand harvesting or using a boat-mounted mechanical harvester to harvest vegetation covering areas larger than 625 square feet requires a permit from the IDNR Division of Fish and Wildlife. (The IDNR Division of Fish & Wildlife can assist lake residents in determining whether a permit is needed and how to obtain one.)

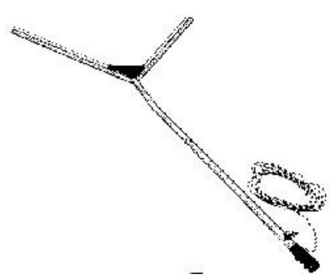


Figure 21. An aquatic weed cutter designed to cut emergent weeds along the edge of ponds. It has a 48" cutting width, uses heavy-duty stainless steel blades, can be sharpened, and comes with an attached 20' rope and blade covers.

9.6 Bottom Covers

Bottom shading by covering bottom sediments with fiberglass or plastic sheeting materials provides a physical barrier to macrophyte growth. Buoyancy and permeability are key characteristics of the various sheeting materials. Buoyant materials (polyethylene and polypropylene) are generally more difficult to apply and must be weighted down. Unfortunately, sand or gravel anchors used to hold buoyant materials in place can act as substrate for new macrophyte growth. Any bottom cover materials placed on the lake bottom must be permeable to allow gases to escape from the sediments; gas escape holes must be cut in impermeable liners. Commercially available sheets made of fiberglass-coated screen, coated polypropylene, and synthetic rubber are non-buoyant and allow gases to escape, but cost more (up to $66,000 per acre or $163,000 per hectare for materials, Cooke and Kennedy, 1989). Indiana regulations specifically prohibit the use of bottom covering material as a base for beaches.

Due to the prohibitive cost of the sheeting materials, sediment covering is recommended for only small portions of lakes, such as around docks, beaches, or boat mooring areas. This technique may be ineffective in areas of high sedimentation, since sediment accumulated on the sheeting material provides a substrate for macrophyte growth. The IDNR requires a permit for any permanent structure on the lake bottom, including anchored sheeting.

9.7 Biological Control

Biological control involves the use of one species to control another species. Often when a plant species that is native to another part of the world is introduced to a new region with suitable habitat, it grows rapidly because its native predators have not been introduced to the new region along with the plant species. This is the case with some of the common pest plants in northeast Indiana such as Eurasian watermilfoil and purple loosestrife. Neither of these species is native to Indiana, yet both exist in and around Noble County.

Researchers have studied the ability of various insect species to control both Eurasian watermilfoil and purple loosestrife. Cooke et al. (1993) points to four different species that may reduce Eurasian watermilfoil infestations: *Triaenodes tarda*, a caddisfly, *Cricotopus myriophylii*, a midge, *Acentria nivea*, a moth and *Litodactylus leucogaster*, a weevil. Recent research efforts have focused on the potential for *Euhrychiopsis lecontei*, a native weevil, to control Eurasian watermilfoil. Purple loosestrife biocontrol researchers have examined the potential for three insects, *Gallerucella calmariensis, G. pusilla*, and *Hylobius transversovittatus,* to control the plant.

While the population of purple loosestrife on Sylvan Lake is relatively small and therefore may not be suitable for biological control efforts, it may be worthwhile for Sylvan Lake residents to understand the common biocontrol mechanisms for this species should the situation on the lake change. Likewise, as Eurasian watermilfoil is present in Sylvan Lake, residents should be cognizant of infestation issues and biocontrol mechanisms for Eurasian watermilfoil. Therefore, treatment options for the plant are discussed below merely as reference material for use in case of future infestation. Residents should also be aware that under new regulations an IDNR permit is required for the implementation of a biological control program on a lake.

9.7.1 Biological Control of Eurasian Watermilfoil

Euhrychiopsis lecontei has been implicated in a reduction of Eurasian watermilfoil in several Northeastern and Midwestern lakes (USEPA, 1997). *E. lecontei* weevils reduce milfoil biomass by two means: one, both adult and larval stages of the weevil eat different portions of the plant and two, tunneling by weevil larvae cause the plant to lose buoyancy and collapse, limiting its ability to reach sunlight. The weevils' actions also cut off the flow of carbohydrates to the plant's root crowns impairing the plant's ability to store carbohydrates for over wintering (Madsen, 2000). Techniques for rearing and releasing the weevil in lakes have been developed and under appropriate conditions, use of the weevil has produced good results in reducing Eurasian watermilfoil. A nine-year study of nine southeastern Wisconsin lakes suggested that weevil activity might have contributed to Eurasian watermilfoil declines in the lakes (Helsel et al, 1999).

Cost effectiveness and environmental safety are among the advantages to using the weevil rather than traditional herbicides in controlling Eurasian watermilfoil (Christina Brant, EnviroScience, personal communication). Cost advantages include the weevil's low maintenance and long-term effectiveness versus the annual application of an herbicide. In addition, use of the weevil does not have use restrictions that are required with some chemical herbicides. Use of the weevil has a few drawbacks. The most important one to note is that reductions in Eurasian watermilfoil are seen over the course of several years in contrast to the immediate response seen with traditional herbicides. Therefore, lake residents need to be patient. Additionally, the weevils require natural shorelines for over-wintering.

The Indiana Department of Natural Resources released *E. lecontei* weevils in three Indiana lakes to evaluate the effectiveness of utilizing the weevils to control Eurasian watermilfoil in Indiana lakes. The results of this study were inconclusive (Scribailo and Alix, 2003), and the IDNR considers the use of the weevils on Indiana lakes an unproven technique and only experimental (Rich, 2005). If future infestation of Eurasian watermilfoil should occur, Sylvan Lake residents should take the lack of proven usefulness in Indiana lakes into consideration before attempting treatment of the lake's Eurasian watermilfoil with the *E. lecontei* weevils.

9.7.2 Biological Control of Purple Loosestrife

Biological control may also be possible for inhibiting the growth and spread of the emergent purple loosestrife. Like Eurasian watermilfoil, purple loosestrife is an aggressive non-native species. Once purple loosestrife becomes established in an area, the species will readily spread and take over the shallow water and moist soil environment, excluding many of the native species which are more valuable to wildlife. Conventional control methods including mowing, herbicide applications, and prescribed burning have been unsuccessful in controlling purple loosestrife.

Some control has been achieved through the use of several insects. A pilot project in Ontario, Canada reported a decrease of 95% of the purple loosestrife population from the pretreatment population (Cornell Cooperative Extension, 1996). Four different insects were utilized to achieve this control. These insects have been identified as natural predators of purple loosestrife in its native habitat. Two of the insects specialize on the leaves, defoliating a plant (*Gallerucella calmariensis* and *G. pusilla*), one specializes on the flower, while one eats the roots of the plant (*Hylobius transversovittatus*). Insect releases in Indiana to date have had mixed results. After six years, the loosestrife of Fish Lake in LaPorte County is showing signs of deterioration.

Like biological control of Eurasian watermilfoil, use of purple loosestrife predators offers a cost-effective means for achieving long-term control of the plant. Complete eradication of the plant cannot be achieved through use of a biological control. Insect (predator) populations will follow the plant (prey) populations. As the population of the plant decreases, so will the population of the insect since their food source is decreasing.

9.8 Chemical Control

Herbicides are the most traditional means of controlling aquatic vegetation. Herbicides have been used in the past on Sylvan Lake as detailed in previous sections. Additionally, it is likely that some residents may have conducted their own spot treatments around piers and swimming areas. It is important for residents to remember that any chemical herbicide treatment program should always be developed with the help of a certified applicator who is familiar with the water chemistry of the target lake. In addition, application of a chemical herbicide may require a permit from the IDNR, depending on the size and location of the treatment area. Information on permit requirements is available from the IDNR Division of Fish and Wildlife or conservation officers.

There are two major disadvantages associated with chemical control of aquatic plants. The primary concern associated with chemical use is user concerns regarding safety. Chemicals undergo rigorous testing prior to licensing. Testing is completed by the USEPA with the final registration occurring within each state. All herbicides are required to result in low toxicity to humans and wildlife and to not persist or bioaccumulate within the environment. Secondarily, users are often concerned due to water use restriction. Restrictions must be posted prior to treatment and can be in the form of irrigation or full body contact. Finally, nutrient releases can occur due to the large volume of dying plant material. This disadvantage can be controlled through correct timing of aquatic plant treatment.

Herbicides vary in their specificity to given plants, method of application, residence time in the water, and the use restrictions for the water during and after treatments. Herbicides occur in two forms: contact and systemic. There are three primary contact herbicides used for controlling submerged aquatic vegetation: diquat (trade name Reward), endothall (trade name Aquathol K), and copper-based formulations (trade names Komeen, Clearigate, and Nautique). Contact herbicides are effective for controlling submerged vegetation on the short term. Such herbicides have historically lacked selectivity resulting in killing non-target plants and sometimes even fish species in a lake. However, recent research suggests that some contact herbicides can be effective for the control of exotic species with relatively minor effects on native species (Skogerboe and Getsinger, 2002). Additionally, it should be noted that the timing and dosage of contact herbicides can improve their selectivity and control, and that this control can be extended to attempt long-term control. Reward is the typical contact herbicide used for mid-season treatment. Diquat or copper-based contact herbicides are fast-acting and, based on this, these herbicides are typically used to control nuisance vegetation around docks or in high-use areas. However, plants can recover quickly from treatments of these herbicides; recovery can occur as quickly as four to eight weeks after treatment.

Research completed by Skogerboe and Getsinger (2002) indicate that treatment rates of endothall as low as 0.5 to 1.0 mg/L can effectively control curly-leaf pondweed and Eurasian watermilfoil. However, higher application rates (1.0 mg/L) of endothall provide better long-term control of curly-leaf pondweed and are required to sustain adequate chemical concentrations within large treatment areas (UPI, no date). Further research indicates that early spring application of endothall at a rate of 1.0 mg/L provides nearly 90% reduction in root biomass production and greater than 90% reduction in turion production (Poovey et al., 2002). (Poovey et al. (2002) defined early spring curly-leaf pondweed treatment as March or April when water temperatures are below 15 ^{o}C, 59 ^{o}F.) Furthermore, research indicates that late spring or early summer treatment after turions have formed is ineffective at long-term control of curly-leaf pondweed and that treatment methodology does not reduce turion production. Aquathol K manufacturers recommend that treatment occur on or before temperatures reach 50 ^{o}F and suggest that early season treatment control "reduces turion production and may reduce the curly-leaf population over time" (UPI, no date). The following treatment rates are their recommendations for effective control of curly-leaf pondweed:

- Large treatment area: 1.0 mg/L (ppm) or 0.6 gallons/acre-foot
- Spot treatment: 1.5 mg/L (ppm) or 1.0 gallons/acre-foot

In Sylvan Lake, treatment would likely occur along large areas and therefore could occur under the lower treatment rate (1.0 mg/L). However, given Sylvan Lake's depth and residence time and the desire for long-term control, it is likely that the higher treatment rate (1.0 mg/L) will provide better long-term control. This translates to application of 0.6 gallons/acre in areas measuring 1 foot deep or less, application of 1.3 gallons/acre in areas 2 feet deep, application of 2.6 gallons/acre in areas 4 feet deep, and 3.8 gallons/acre in areas measuring 8 feet deep (UPI, 2007).

Systemic herbicides are those that work within the system of the plant itself. These herbicides are transported to the root system resulting in killing the entire plant. The three most common systemic herbicides used for the control of Eurasian watermilfoil are fluoridone (trade name Sonar or Avast!), 2,4-D (trade name Aqua-Kleen, DMA4, or Navigate), and triclopyr (trade name Renovate). (Additionally, imazapyr, glyphosate, and triclopyr can be used for the control of purple loosestrife.) Fluoridone is typically recommended for whole lake treatment of Eurasian watermilfoil and curly-leaf pondweed due to the lower tolerance of these species to fluoridone compared with other aquatic plant species. Smith (2002) noted control of Eurasian watermilfoil to the point of limited detectability following whole-lake treatment with fluoridone. Additionally, most Eurasian watermilfoil strains have a lower tolerance to fluoridone than most other aquatic plant species; therefore, if fluoridone is properly applied, control of Eurasian watermilfoil can occur with little harm to native species (AERF, 2005).

Triclopyr and 2,4-D are typically used for spot treatment of small areas of broad-leaf plants (dicots) like coontail, watermilfoil, and waterweed. Treatment with triclopyr is a good option if Eurasian watermilfoil populations are not dense or abundant. Treatment using triclopyr must be aggressive in order to result in adequate Eurasian watermilfoil control. Neither chemical affects monocots such as eel grass or pondweeds and are not effective in the control of curly-leaf pondweed. 2,4-D is a cheaper alternative than triclopry; however, 2,4-D can impact other native species like coontail.

While providing a short-term fix to the nuisances caused by aquatic vegetation, chemical control is not a lake restoration technique. Herbicide and algaecide treatments do not address the reasons why there is an aquatic plant problem, and treatments need to be repeated each year to obtain the desired control. In addition, some studies have shown that long-term use of copper sulfate (algaecide) has negatively impacted some lake ecosystems. Such impacts include an increase in sediment toxicity, increased tolerance of some algae species, including some blue-green (nuisance) species, to copper sulfate, increased internal cycling of nutrients, and some negative impacts on fish and other members of the food chain (Hanson and Stefan, 1984 cited in Olem and Flock, 1990).

Chemical treatment should be used with caution on Sylvan Lake since treated plants are often left to decay in the water. This will contribute nutrients to the lake's water column. Additionally, plants left to decay in the water column will consume oxygen. Historic water quality sampling showed that Sylvan Lake possessed relatively moderate nutrient concentrations compared to many Indiana lakes. Nonetheless, as evidenced during the plant survey, the lake's total phosphorus concentration is high enough to support filamentous algae and, based on the water chemistry samples collected during the previous in-lake assessments (Crisman, 1990), the lake may also experience algal blooms. The plankton community present in Sylvan Lake illustrates this issue in that the community is dominated by blue-green algae. Furthermore, the blue-green algae that comprised the largest portion of the plankton community have been known to cause taste, odor, and toxicity problems in other lakes. Chemical treatment is likely the best way to control growth and spread of Eurasian watermilfoil and curly-leaf pondweed in Sylvan Lake. Herbicides (and algaecides; chara is an algae) that are non-specific or require whole lake applications to work are generally not recommended for treatment in Sylvan Lake.

9.9 Preventive Measures

Preventive measures are necessary to curb the spread of nuisance aquatic vegetation. Although milfoil is thought to 'hitchhike' on the feet and feathers of waterfowl as they move from infected to uninfected waters, the greatest threat of spreading this invasive plant is humans. Plant fragments snag on boat motors and trailers as boats are hauled out of lakes (Figure 22). Milfoil, for example, can survive for up to a week in this state; it can then infect a milfoil-free lake when the boat and trailer are launched next. It is important to educate boaters to clean their boats and trailers of all plant fragments each time they retrieve them from a lake. The Stop Aquatic Hitchhikers! campaign offers information on the prevention of spreading exotic invasive species. Visit their website at for more information: www.protectyourwaters.net

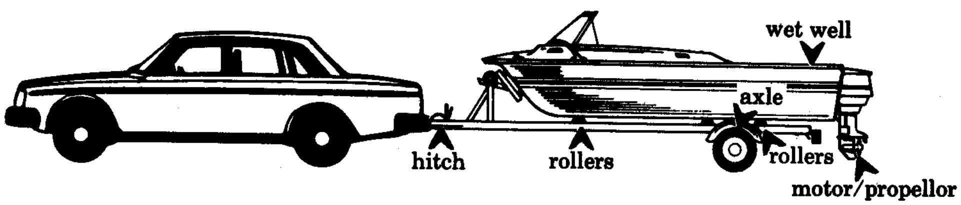


Figure 22. Locations where aquatic macrophytes are often found on boats and trailers.

Educational programs are effective ways to manage and prevent the spread of aquatic nuisance species (ANS) such as Eurasian watermilfoil, zebra mussels, and others. Of particular help are signs at boat launch ramps asking boaters to check their boats and trailers both before launching and after retrieval. All plants should be removed and disposed of in refuse containers where they cannot make their way back into the lake. The Illinois-Indiana Sea Grant Program has examples of boat ramp signs and other educational materials that can be used at Sylvan Lake. Eurasian watermilfoil is present in Sylvan Lake and other area lakes; therefore, educational programs and lake signage will help prevent the spread of this nuisance species into other parts of the lake or into other area lakes. This is particularly important given the popularity of Sylvan Lake. Non-resident anglers and other visitors will use their boats in other lakes in addition to Sylvan Lake, potentially spreading Eurasian watermilfoil to uninfested lakes. Signs addressing any best management practices to prevent the spread of nuisance aquatic species will ultimately help protect all lakes as new nuisance (often non-native) species are finding their way to Indiana lakes all the time. The IDNR can provide these signs in electronic format if the SLIA wishes to handle printing and posting.

10.0 Public Involvement

The LARE biologist, district fisheries biologist, and association representative met November 9, 2007 to discuss the 2007 aquatic plant treatment and identify aquatic plant treatment options for 2008. From this meeting, it was determined that the following would occur:

1. All areas identified as possessing dense Eurasian watermilfoil beds should be treated in 2008.
2. Efforts to adequately catalog the curly-leaf pondweed community with early season surveys should also occur.
3. Since it is deemed necessary and of high priority for Sylvan Lake residents, a plan for treatment of curly-leaf pondweed should be continued based on the early season 2008 surveys.

Based on this information, a grant application to treat Eurasian watermilfoil and curly-leaf pondweed should be submitted to the LARE program staff. Although LARE aquatic plant treatment funds are limited, future efforts are targeted at accommodating Eurasian watermilfoil and early-season curly-leaf pondweed treatments. Money may be available for Eurasian watermilfoil and curly-leaf pondweed treatment in the future.

11.0 Public Education

Education efforts targeting information about Indiana's newest aquatic species of concern hydrilla, which was identified in Lake Manitou (Fulton County) in 2006. Hydrilla is an extremely aggressive submerged aquatic plant species that looks similar to common elodea. The basic difference is the number of leaves: hydrilla contains five leaves while common elodea only contains three leaves. Appendix D contains more detailed information on hydrilla, its habitat, and its distribution. Efforts to educate individuals on the control, spread, and issues associated with this and other exotic species should follow the Stop Aquatic Hitchhikers! Campaign which can be found at www.protectyourwaters.net. At a minimum, the SLIA should post warnings and send information to Sylvan Lake residents about this plant.

Finally, steps can be taken by individual property owners that will also help preserve and enhance Sylvan Lake. The following is a list of potential actions that individuals can undertake:

1. Reduce the frequency and amount of fertilizer, herbicide, or pesticide used for lawn care.
2. Use only phosphorus-free fertilizer.
3. Consider re-landscaping lawn edges, particularly those along the watershed's lakes, to include low profile prairie species that are capable of filtering runoff water better than turf grass.
4. Consider resurfacing concrete or wooden seawalls with glacial stone, then planting native emergent vegetation along shorelines or in front of resurfaced or existing concrete or wooden seawalls to provide fish and invertebrate habitat and dampen wave energy.
5. Keep organic debris like lawn clipping, leaves, and animal waste out of the water.
6. Properly maintain septic systems. Systems should be pumped regularly and leach fields should be properly cared for.
7. Examine all drains that lead from roads, driveways, and rooftops to the watershed.
8. Obey speed limits through the lakes.
9. Thoroughly clean all material from boats and trailers after lake use and refrain from dumping bait buckets into the lake to prevent the spread of exotic species.
10. Accept the presence of native aquatic vegetation.
11. Do not destroy emergent vegetation growing along the shoreline.
12. Minimize the size of impact area for use of piers and beaches.

12.0 Integrated Management Action Strategy

The focus of the action strategy should be to meet the three goals identified earlier. These are as follows:

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species.
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Each goal, along with objectives to meet this goal, is listed below. Following each objective are the actions which should be taken in order to achieve the objective.

12.1 Goal 1: Maintain a stable and diverse aquatic plant community.

The focus of the first goal is on the development and maintenance of a stable, diverse aquatic plant community. To meet this goal, the SLIA should focus both on the emergent plant community and on the submerged plant community as both of these combine to create the aquatic plant community currently present within Sylvan Lake.

Objective 1: Maintain and enhance the diversity of the rooted floating and emergent portions of the aquatic plant community.

Sylvan Lake's rooted plant diversity and the areas of rooted and floating species should be protected and enhanced, if possible. The typical community displayed in Figure 23 details the density and diversity that is present in the lake. The lake supports moderate rooted plant diversity within the upper basins and this undoubtedly plays a role in supporting its healthy fishery. The density and diversity of the shallow water, emergent plant community prevents shoreline erosion and sediment resuspension; limits the ability for nuisance waterfowl to enter and exit the water onto the shoreline; provides habitat and cover for fish, amphibians, birds, and other wildlife; and filters nutrients that enter the lake from the lakeshore. Management techniques that are not species specific, such as contact herbicides, large scale harvesting, or dredging in bays, should be avoided to ensure the protection of the high quality community. Additionally, Sylvan Lake residents may wish to consider re-establishing portions of the emergent plant community that previously existed in the lake. One particular area in which this could occur would be the area around Twin Island where boating access is limited. Additionally, restoration of eroding shorelines would also enhance the emergent and rooted floating plant community.

Figure 23. Typical emergent and rooted floating plant community present in Sylvan Lake.

Sylvan Lake residents should also take steps to restore the lake's shoreline vegetation. Purple loosestrife and reed canary grass were identified in several locations along Sylvan Lake's lakeshore and in adjacent lawns. Both of these species are introduced from Eurasia and spread rapidly through prolific seed production, vegetative growth, and cultivation. Without individual control, both species can spread along the lakeshore inhibiting boat mooring and individual access to the lake. The LARE program does not typically provide funding for the control of either of these species due to budget constraints. Nonetheless, residents should become familiar with these plants and methods for their control. The two easiest ways to control the spread of both species is through hand pulling or digging and the application of herbicides. If hand digging is the selected method for removal, individuals should be sure to remove the entire root structure as purple loosestrife can re-sprout from the roots. The use of chemicals can limit regrowth. Any chemicals used to control these species must be approved for application near water, such as Rodeo. Removal of these species and restoration of the shoreline would return many of the functions provided by healthy riparian areas. Landowners should replace these plants with native species that provide equal or better quality aesthetics and are more useful to birds, butterflies, and other wildlife as habitat and a food source. Reed canary grass should be replaced with switch grass, Indian grass, or even big blue stem depending on the landowner's desired landscaping. Swamp blazing star, swamp milkweed, cardinal flower, blue-flag iris, or blue lobelia all offer more habitat and aesthetic variety than that offered by purple loosestrife. A mixture of these species will also allow for colorful blooms throughout the growing season.

Objective 2: Maintain the density and diversity of the submerged portion of the aquatic plant community.
Sylvan Lake's aquatic plant community is relatively diverse. The lake's submerged community contained 11 and 13 species during the two aquatic plant surveys. This diversity is normal for area lakes and could be improved with improved water quality and control of exotic species. The variety of submerged plant species present in Sylvan Lake provides fish cover and habitat for macroinvertebrates, amphibians, and reptiles; filters nutrients; and increases the aesthetic conditions present in Sylvan Lake. Lake residents and users should become aware of the quality of their aquatic plant community and should limit the control or removal of the native populations of submerged aquatic plants. Native species should be controlled only in those locations where the density of aquatic plants limits the owner's aesthetic value or negatively impacts lake use. Control of native communities should be limited in shallow areas or around docks; treatment should only occur if there are difficulties in maneuvering boats to and from docks or other shoreline structures. Other specifics of native plant control are detailed below.

12.2 Goal 2: Reduce negative impacts from exotic and/or invasive species.
The focus of the second goal is on reducing the negative impacts from aquatic exotic or invasive species. This goal can be accomplished by reducing the density and coverage of current populations of exotic and/or invasive species and preventing the introduction of new species and the spread of current species to areas of the lake where exotic, invasive species are currently not present. Goal 2 builds on the objectives detailed in Goal 1 in that efforts to reach Goal 2 will assist the SLIA in reaching Goal 1.

Objective 1: Reduce the density and abundance of Eurasian watermilfoil.
Eurasian watermilfoil is present in relatively high density in relatively contained locations within Sylvan Lake. In order to prevent the continued spread of Eurasian watermilfoil to other locations within the lake, a control program should be enacted. Eurasian watermilfoil reproduces through fragmentation and can rapidly spread to other areas of the lake and can reach nuisance levels. This species can displace native vegetation and has a tendency to form dense canopies that shade out native vegetation. In order to control Eurasian watermilfoil within Sylvan Lake, the use of 2,4-D (Navigate) or Renovate for spot treatment of populations is recommended. Up to 19 acres of Eurasian watermilfoil are recommended for treatment (Figure 24). The cost of this treatment is approximately $10,000 if 2,4-D is used for treatment within Sylvan Lake. Additional annual follow-up treatments would likely be necessary to control Eurasian watermilfoil populations within Sylvan Lake.

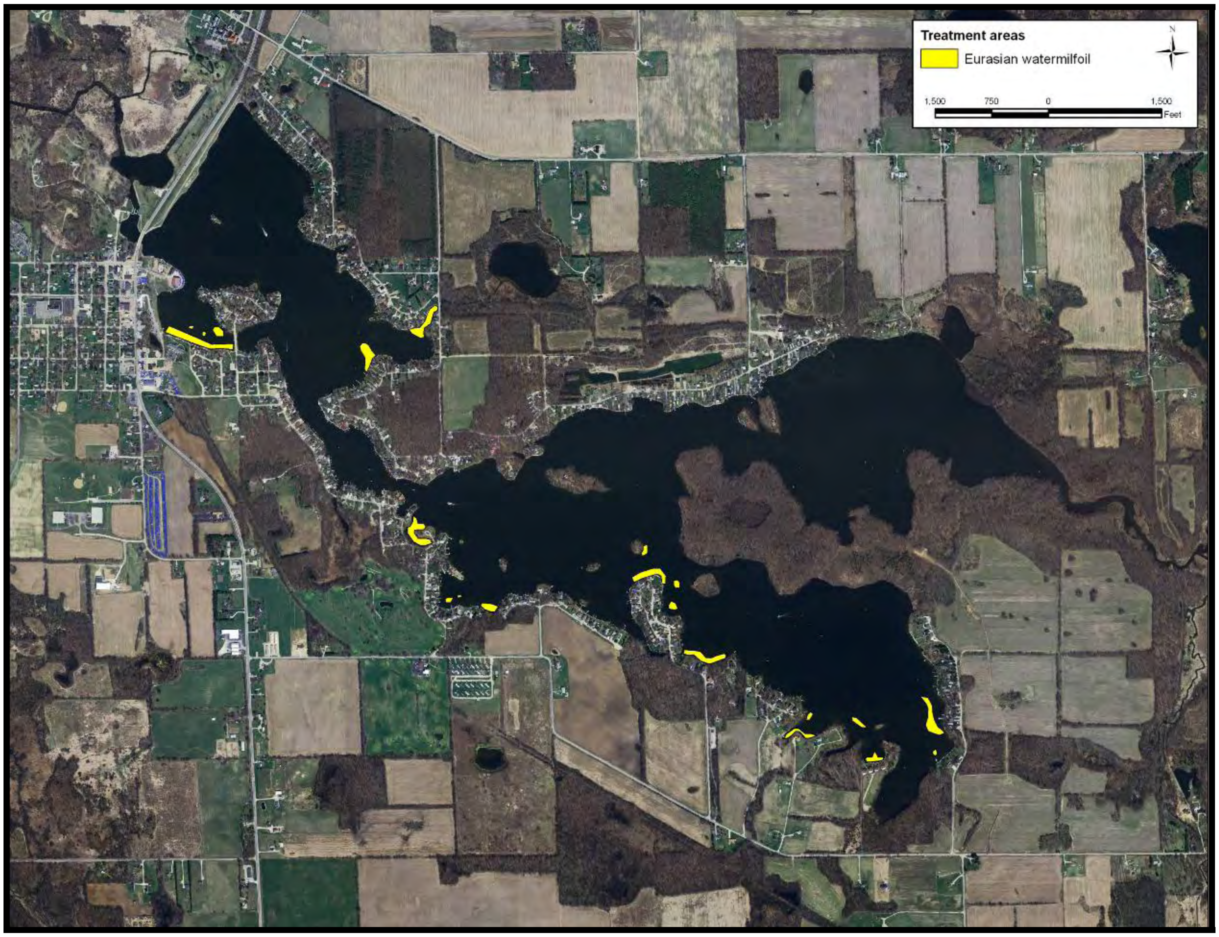


Figure 24. Eurasian watermilfoil population control recommendations for 2008.

In order to aid in the control of Eurasian watermilfoil, lake residents and users should be educated as to their impact on the spread of the plant. Eurasian watermilfoil spreads through fragmentation, which allows one small piece of Eurasian watermilfoil to colonize other areas of the lake. It is very important that boaters avoid driving through areas of the lake currently infested with Eurasian watermilfoil as this can chop the plant thereby creating fragments. These fragments can then be carried to other areas on boat propellers or float to other areas of the lake. It is also important the boaters remove all plant fragments from their boat propeller and trailer before traveling from lake to lake. If signs are currently not posted at the boat ramp detailing the need to clean boats and trailers, then signs should be posted warning boat owners and users to check their equipment for plant fragments.

Objective 2: Reduce the density and abundance of curly-leaf pondweed..

Treatment of curly-leaf pondweed through the LARE program has typically been limited to those lakes where infestations cover large percentages of the water's surface area. Sylvan Lake is one such lake where curly-leaf pondweed treatment is funded through the LARE program. Curly-leaf pondweed typically senesces during the height of the recreational season, which is one reason that treatment of this species is not always of high priority. However, curly-leaf pondweed can be a nuisance and control should be initiated as part of the long-term strategy to protect and improve the native submerged plant community. Curly-leaf pondweed is currently found throughout the lake and is especially dense in the headwater of Pit Lake and Cain Lake basins. In total, curly-leaf pondweed covers approximately 200 acres of Sylvan Lake (Figure 25). Historically, curly-leaf pondweed covered nearly 300 acres of Sylvan Lake. The SLIA's long-term goal is to reduce curly-leaf pondweed density within the lake resulting in its eradication from the lake. An acceptable percent cover of the lake has not been determined at this time. However, discussion with the SLA suggests that less than 10% cover of curly-leaf pondweed within the lake would meet their expectations. An acceptable cover for Eurasian watermilfoil in Sylvan Lake is also suggested to be less than 10%. As such, these areas likely contain resident turions which are present within the sediment covering this portion of the lake. Aquathol K is recommended for treatment of these areas and should continue to occur over several consecutive summers to reduce the growth and production of turions, which can last for multiple seasons after treatment. Given the desire to ensure long-term control of curly-leaf pondweed and to reduce the production of turions, curly-leaf pondweed treatment should occur at a rate of 1 mg/L (0.6 gallons/acre in shallow water to 3.8 gallons/acre in deeper water) before water temperatures reach 50 °F. Estimates completed by Weed Patrol suggest that treatment of curly-leaf pondweed should continue to decline over time with an estimated treatment of 300 acres in 2008.

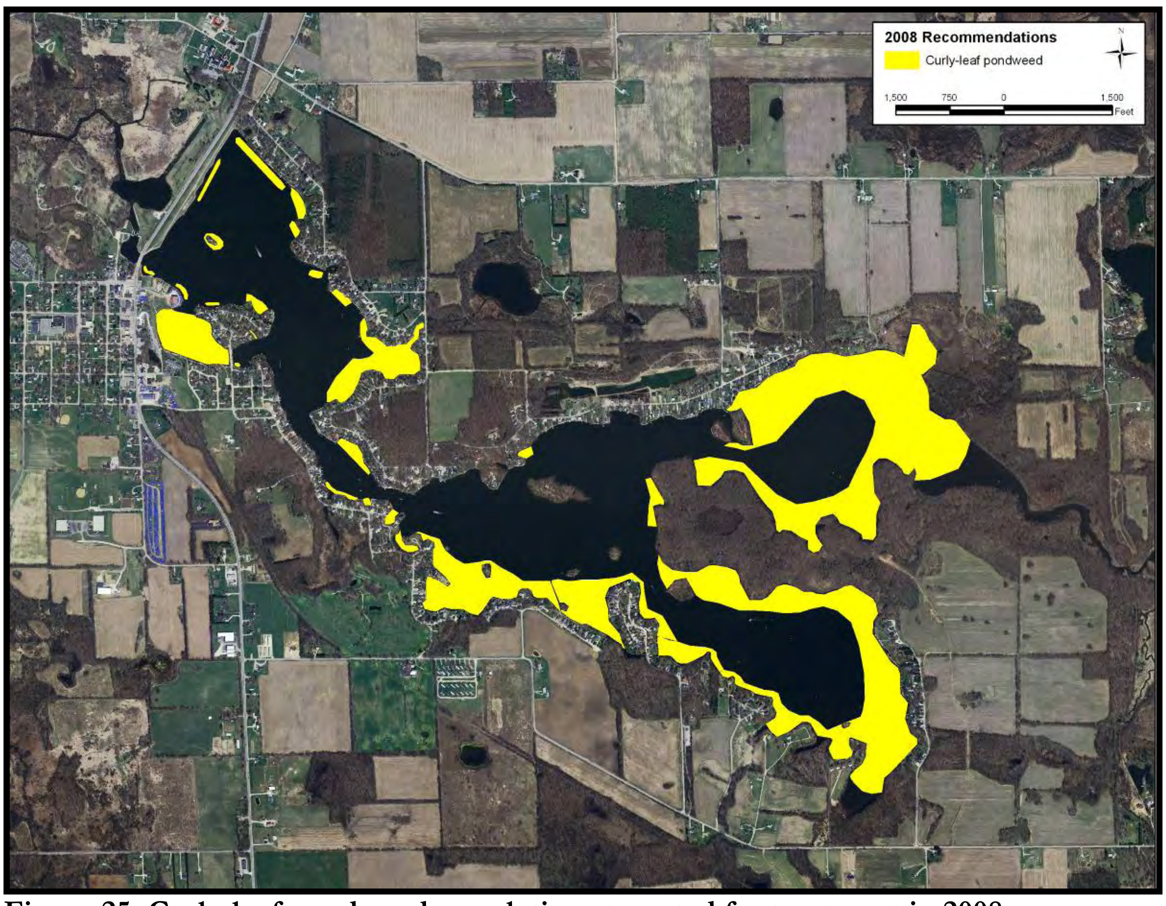


Figure 25. Curly-leaf pondweed populations targeted for treatment in 2008.

Objective 3: Prevent the spread of purple loosestrife and reed canary grass.

Both purple loosestrife and reed canary grass can be detrimental to native shoreline and wetland species. Currently, control of these species is not funded through the LARE program. Nonetheless, if either of these species are present on an individual property, then the species should be removed through hand pulling and removal of the root structure. Removal should occur prior to the plants flowering.

Objective 4: Educate lake users and shoreline owners about the impacts of exotic and invasive species.
Currently, Indiana is home to four aquatic exotic, invasive species: Eurasian watermilfoil, curly-leaf pondweed, Brazilian elodea, and hydrilla. To date, Brazilian elodea and hydrilla are limited to one lake each: Brazilian elodea occurs in Griffy Lake in Bloomington, Indiana and hydrilla occurs in Lake Manitou in Rochester, Indiana. In order to prevent the spread of this and other exotic species, lake users should be educated regarding the potential impacts of these species and the threat of their spread. All three species spread by fragmentation allowing them to spread from one area to another within a lake and from lake to lake. Therefore, it is imperative that users remove all plant fragments from boats and trailers when entering and exiting lakes. Posting signs at the boat ramp will help reinforce this effort. The SLIA should include information about hydrilla, Eurasian watermilfoil, and curly-leaf pondweed in their newsletters and on their website. Educational information about these and other exotic species can be found at the Stop Aquatic Hitchhikers! website (www.protectyourlake.net.).

12.3 Goal 3: Provide reasonable recreational access while minimizing the negative impacts on plants, fish, and wildlife resources.

This goal focuses on the control of exotic species for recreational purposes; however, the control of a limited number of native species, including coontail, may also be necessary to meet reasonable recreational access goals. Sylvan Lake is primarily a recreation lake where swimming, fishing, and pleasure boating are balanced with skiing, high speed boating, and the use of personal watercraft. In order to maintain aesthetic and ecological quality in Sylvan Lake, it may be necessary to balance recreational uses.

Objective 1: Allow boat access through the control of aquatic vegetation around boat docks.
Native species proliferate in many areas of Sylvan Lake. If allowed to continue to grow, these plants may begin to restrict shoreline owner access to the lake from their dock. In these areas, hand removal or spot chemical treatment of plants should be implemented. Up to 625 square feet of vegetation can be removed from an individual shoreline without a permit. Removal of native aquatic vegetation should be limited in Sylvan Lake to only those areas where boat access is necessary. This typically measures 20 to 30 feet off of the shoreline. Native vegetation areas that remain shallow but occur outside this distance from the shoreline should be allowed to continue in their native form. Additionally, aquatic plants should not be treated farther than 100 feet from the lakeshore. No extraneous removal of aquatic vegetation is recommended at this time. If plants are removed from the lake by hand, they should not be left along the shoreline to desiccate. Rather, plants should be removed from the lakeshore and deposited in compost piles, gardens, or bagged for removal. If hand-pulling is not an option, residents should contact a certified aquatic applicator to implement treatment.

Objective 2: Control coontail population growth along shallow, populated areas of the lake.
Coontail growth along the shallow shelf present in the lower basin of Sylvan Lake has reached nuisance levels. Areas where control should occur is limited to those locations where coontail limits individual's access from their pier to the lake. Additionally, treatment should not occur along natural,

undeveloped shorelines or in areas where boat access is not a high priority. The areas prioritized for treatment are displayed in Figure 26.

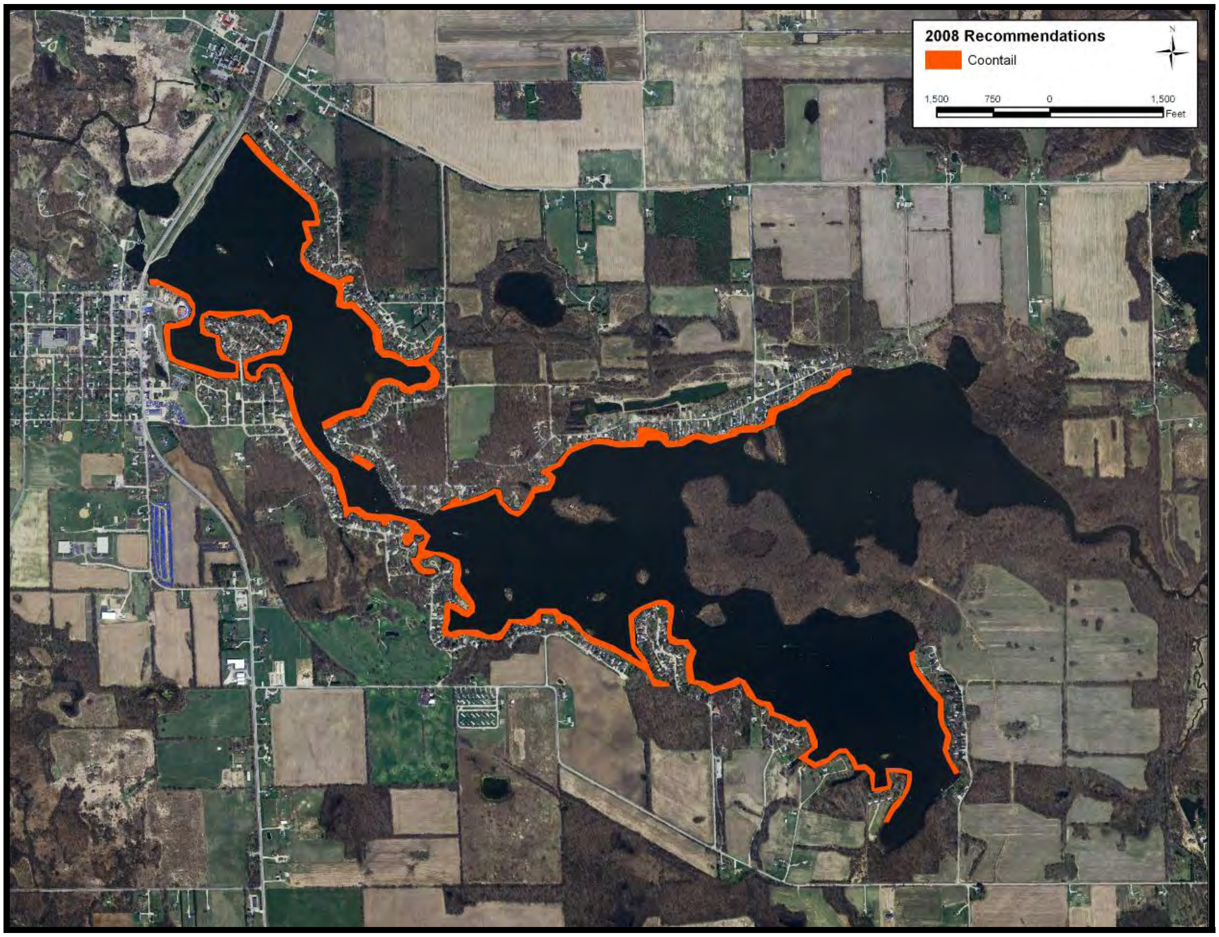


Figure 26. Priority areas of coontail treatment in 2008.

12.4 Immediate Action Plan

The LARE Aquatic Plant Management Plan grant was provided to the Sylvan Lake Improvement Association for the purpose of funding aquatic vegetation controls on the lake. These controls should be approached using a three-prong effort: control of exotic species and nuisance native species; restoration or preservation of native plant communities; and education of lake users. Below, recommended actions are listed in order of importance. It should be noted that some of these actions may be funded through the LARE program; however, alternate sources of public or private monies may need to be obtained by the SLIA in order to implement these actions.

1. Continue treatment of Sylvan Lake's curly-leaf pondweed population with low-dose (1 mg/L) Aquathol K before water temperatures reach 50 °F. This treatment should be initiated across a 300 acre swath of the lake in 2008 and should continue throughout the five year planning period (2007-2011).
2. Continue spot treatment of up to 25 acres of Eurasian watermilfoil and coontail throughout the lake. Areas to be treated are located along much of the developed shoreline of the lake, which possesses a narrow shelf upon which dense aquatic plant growth occurs. Treatment should occur along only those areas where resident access is a priority. Additionally,

treatment should be limited to 50 feet from shoreline, if possible but may extend to 100 feet from the shoreline.

3. Monitor the plant community using aquatic plant surveys for next five years (2008-2012). These surveys should occur both prior to treatment and following treatment to assess the effectiveness of controls and response of native plant community to these treatments. Surveys should include an assessment of the number of turions present in the substrate, if a method is developed and included in the IDNR monitoring program. In 2008, surveys should consist of a reconnaissance survey and a Tier II survey prior to treatment of either curly-leaf pondweed or Eurasian watermilfoil. A second, post-treatment reconnaissance survey and Tier II survey should occur following treatment. Efforts should be made to align post-treatment survey dates with similar dates of surveys in the past. These surveys should be continued through 2012.
4. Post signs at all access sites in warning boaters of the potential for invasive plant species introductions from boat trailers. Signs should implore boaters to clean trailers, propellers, and boats of all vegetative fragments when entering and leaving Sylvan Lake. This is especially important given the high density of off-shore users on the lake. Information concerning the potential spread of Eurasian watermilfoil and hydrilla should be distributed to all SLIA members and lake users.
5. Investigate potential options to reduce nutrient and sediment loading to the lake through watershed management planning or implementation projects.
6. Remove purple loosestrife and reed canary grass from individual properties.
7. Maintain dock areas with physical plant removal when possible or by contracting professional applicators. Treatments should not exceed 100 feet from shoreline for submersed vegetation and treatment of rooted floating vegetation should be limited to boating lanes.
8. Educate lake users on best management practices in order to improve water quality.

13.0 Project Budget

Table 11 contains an **estimated** budget for the aquatic vegetation management action plan. The majority of the annual cost is associated with annual curly-leaf pondweed control costs, which are estimated to occur across the 300 acre area annually for five years. Each year's treatment should be reduced in acreage; however, this may not occur until later in the treatment cycle. Because the main treatment recommended in Sylvan Lake consists of curly-leaf pondweed treatment with the idea of reducing the resident population over time, it is necessary for both pre-treatment and post-treatment reconnaissance and Tier II surveys to occur within Sylvan Lake. From these surveys, treatment and community distributions maps will be developed. It is our recommendation that the Sylvan Lake Improvement Association requests $29,000 from the LARE program. This budget includes the $20,000 maximum per lake for in-lake treatment and $9,700 for aquatic plant surveys and plan updates. All additional treatment of curly-leaf pondweed, Eurasian watermilfoil, coontail, and/or algae must be funded through the lake association. A permit for this treatment is included in Appendix E. This permit should be submitted by the association and, once a contractor is selected for the treatment, the permit can be completed. It is possible that this project may not be fully-funded due to a recent hydrilla infestation in Lake Manitou that may use a large percentage of potential LARE funds.

Table 12. Budget estimate for the action plan, 2008-2012.

Task	2008	2009	2010	2011	2012
Curly-leaf pondweed treatment	$97,500	$81,250	$65,000	$48,750	$48,750
Eurasian watermilfoil treatment	$9,375	$9,375	$9,375	$9,375	$9,375
Plant sampling and plan update	$7,500	$7,500	$7,500	$7,500	$7,500
Early-season assessment	$2,200	$2,200	$2,200	$2,200	$2,200
Native plant and algae treatment	$5,000	$5,000	$5,000	$5,000	$5,000
Total	**$121,575**	**$105,325**	**$89,075**	**$72,825**	**$72,825**

Costs for aquatic plant assessment and treatment in 2008 are as follows:

- Eurasian watermilfoil treatment of approximately 25 acres with 2,4-D at a cost of $325 per acre for a total cost of $9,375.
- Early season curly-leaf pondweed assessment and treatment. Assessment will include a Tier II survey prior to treatment and mapping of the curly-leaf pondweed community. Turion assessment should be included if a standard method for this type of assessment is developed. Early season assessment is estimated to cost $2,200, which does not include turion assessment. Treatment costs will depend upon the acreage identified for treatment. Based on previous years' treatments, it is anticipated that 300 acres of curly-leaf pondweed treatment with Aquathol K will be necessary. Aquathol K should be applied at a rate of 1.0 mg/L (0.6 to 3.8 gallons/acre). It is estimated that treatment of this acreage (300 acres) at this rate (1.0 mg/L) will cost approximately $325/acre for a total cost of $97,500
- Additionally, non-LARE funded treatment of algae throughout the lake and coontail treatment of approximately 25 acres with contact herbicides is also recommended. Overall, these treatments are anticipated to cost $5,000.
- Standard LARE assessment, public meeting, and plan update costs are based on 2007 LARE requirements (pre-treatment exotic species distribution survey; one post-treatment Tier II survey; public meeting; plan update). Assessment costs are estimated to total $2,500, while the plan update is anticipated to occur at a cost of $5,000.

Total fees for 2008 aquatic plant assessment, herbicide application, and plan updated are estimated at $121,575. LARE has historically provided funding of up to $20,000 for aquatic plant treatment and provides monies for surveys and plan updates. All of these monies require a 10% match.

The following time schedule is anticipated for aquatic plant management activities for Sylvan Lake in 2008:

March-April 2008	Curly-leaf pondweed assessment (Tier II survey and mapping)
April-early May, 2008	Curly-leaf pondweed treatment
May 15-June 15, 2008	Eurasian watermilfoil and coontail treatment
July 15-August 30, 2008	Tier II post-treatment assessment
August-September, 2008	Public meeting
November 2008	Meeting between IDNR LARE and fisheries staff, CLCA, and contractor
December 15, 2008	Plan update and permit
January 15, 2009	LARE application for 2009 funding due

14.0 Monitoring and Plan Update Procedures

Monitoring shall follow procedures determined by the LARE program. Likewise, plan updates will conform to LARE requirements. This includes, but is not limited to: early season assessment and treatment for curly-leaf pondweed, post-treatment surveys, exotic species map development, and public meetings and outreach. This will allow for continued monitoring of the aquatic plant community within Sylvan Lake, which is one of the primary goals of the LARE aquatic plant management planning program. Additionally, continued monitoring will allow for the determination of the effectiveness of control methods, identify changes in the native plant community, and detect the extent of known and future exotic species infestations. Each year's data should be analyzed and used to revise or update this plan and implementation strategy which may subsequently lead to changes in the initial recommendations in this plan.

15.0 References Cited

Aikens, S.A. P.R. Newroth, and I. Wile. 1979. The biology of Canadian weeds, 34 *Myriophyllum spicatum*. L. Can. J. Plant Sci. 59:201-215.

Aquatic Ecosystem Restoration Foundation. 2005. Aquatic Plant Management: Best management practices in support of fish and wildlife habitat.

Cooke, G.D., and R.H. Kennedy. 1989. Water Quality Management for Reservoirs and Tailwaters. Report 1. In-lake Reservoir Water Quality Management Techniques. Tech. Rep. E-89-1. U.S. Army Corps of Engineers. Vicksburg, Mississippi.

Cooke, G.D., E.B. Welch, S.A. Peterson and P.R. Newroth. 1993. Restoration and Management of Lakes and Reservoirs, Second Edition. Lewis Publishers, Boca Raton.

Cornell Cooperative Extension. 1996. Video- "Restoring the Balance: Biological Control of Purple Loosestrife". Cornell University Media Services, Ithaca, New York.

Crisman, T.L. 1990. A final feasibility study for Sylvan Lake, Indiana. Sylvan Lake Improvement Association, Rome City, IN. 124 pp.

Cross, T. K., M. C. McInherny, and R. A. Davis. 1992. Macrophyte removal to enhance bluegill, largemouth bass and northern pike populations. Section of Technical Services Investigational Report 415. Minnesota Department of Natural Resources, Division of Fish and Game, St. Paul, MN.

DeLorme. 1998. Indiana Atlas and Gazetteer.

Grant, W. 1989. A preliminary investigation of twenty-four lakes in Lagrange County, Indiana. Indiana Department of Natural Resources, T-by-2000 Program, Indianapolis, Indiana.

Hanson, M.J. and H.G. Stefan. 1984. Side effects of 58 year of copper sulfate treatment of the Fairmont Lakes, Minnesota. Water Res. Bull. 20:889-900.

Helsel, D.R., S.A. Nichols and R.S. Wakeman. 1999. Impact of aquatic plant management methods on Eurasian watermilfoil populations in southeast Wisconsin. J. Lake and Reserv. Mgmt., 15(2): 159-167.

Indiana Department of Natural Resources. 2007. Tier II aquatic vegetation survey protocol. Indianapolis, Indiana.

Madsen, J.D. 2000. Advantages and disadvantages of aquatic plant management. LakeLine, 20(1):22-34.

McComas, S. 1993. Lake Smarts. The Terrene Institute, Washington, D. C. 215 pp.

Olem, H. and G. Flock, eds. 1990. Lake and Reservoir restoration guidance manual. 2nd edition. EPA 440/4-90-006. Prepared by NALMS for USEPA, Washington, D.C.

Olsen, M. H., S. R. Carpenter, P. Cunningham, S. Gafny, B. R. Herwig, N. P. Nibbelink, T. Pellett, C. Storlie, A. S. Trebitz, and K. A. Wilson. 1998. Managing macrophytes to improve fish growth: a multi-lake experiment. Fisheries 23:6-12.

Pearson, J. 1987. The Sylvan Lake fish improvement project: A final assessment. Indiana Department of Natural Resources. 26 pp.

Pearson, J. 2004. A sampling method to assess occurrence, abundance and distribution of submersed aquatic plants in Indiana lakes. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Poovey, Angela G., Skogerboe, J.G. and C.S. Owens. 2002. Spring Treatments of Diquat and Endothall for Curlyleaf Pondweed Control. Journal of Aquatic Plant Management, 40: 63-67.

Rich, C.F. 2005. Correspondence with JFNew regarding the Four Lakes Diagnostic Study dated June 17, 2005.

Scribailo, R.W. and M.S. Alix. 2003. Final report on the weevil release study for Indiana lakes. Indiana Department of Natural Resources, Division of Soil Conservation, Indianapolis, Indiana.

Skogerboe, J.G. and K.D. Getsinger. 2002. Endothall species selectivity evaluation: northern latitude aquatic plant community. Journal of Aquatic Plant Management, 40: 1-5.

Smith, C.S. 2002. Houghton Lake management feasibility study. Prepared for the Houghton Lake Improvement Board. Remetrix LLC, Indianapolis, Indiana.

Swink, F. and G. Wilhelm. 1994. Plants of the Chicago region. 4th Edition. Indianapolis: Indiana Academy of Science.

United States Environmental Protection Agency. 1997. Use of aquatic weevils to control a nuisance weed in Lake Bomoseen, Vermont. Watershed Protection: Clean Lakes Case Study. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 841-F-97-002.

United Phosphorus, Inc. No date. Early Season Control of Curly-leaf pondweed.

United Phosphorus, Inc. 2007. Early Season Control of Curly-leaf pondweed.

Valley, R. D., T. K. Cross, and P. Radomski. 2004. The role of submersed aquatic vegetation as habitat for fish in Minnesota lakes, including implications of non-native plant invasions and their management. Special Publication 160. Minnesota Department of Natural Resources, Division of Fish and Wildlife, St. Paul, MN.

Weed Patrol, Inc. 2005. Sylvan Lake Aquatic Vegetation Management Plan Draft. Noble County, Indiana. Elkhart, IN.

APPENDIX A:

LAKE USER SURVEY RESULTS

SYLVAN LAKE
AQUATIC PLANT MANAGEMENT PLAN REVISION 2007

Lake Use Survey Results: October 24, 2007
32 Respondents

Lake Name: Sylvan Lake

Are you a lake property owner? Yes 100% No____

Are you currently a member of your lake association? Yes 97.3% No___

How many years have you been at the lake?
<2 yrs 12.5% 2 – 5 yrs 9.4% 5-10 yrs 9.4% > 10 years 68.8%

How do you use the lake (mark all that apply)
93.8% Swimming 53.1% Irrigation 96.9% Boating 0.00% Drinking water
84.4% Fishing 3.1% Other

Do you have aquatic plants at your shoreline in nuisance quantities?
Yes 90.6% No 9.4%

Do you currently participate in a weed control project on the lake?
Yes 84.4% No 3.1%

Does aquatic vegetation interfere with your use or enjoyment of the lake?
Yes 78.1% No12.5%

Does the level of vegetation in the lake affect your property values?
Yes 84.4% No 12.5%

Are you in favor of continuing efforts to control vegetation on the lake?
Yes 100% No ___

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded?
Yes 68.8% No 25%

Mark any of these you think are problems on your lake:
21.9% Too many boats access the lake
21.9% Use of jet skis on the lake
12.5% Too much fishing
9.4% Fish population problem
75% Dredging needed
21.9% Overuse by nonresidents
90.6% Too many aquatic plants
0.00% Not enough aquatic plants
53.1% Poor water quality
9.4% Pier/funneling problem

Please add any comments:
____

APPENDIX B:

TIER II SURVEY RAW DATA

SYLVAN LAKE
AQUATIC PLANT MANAGEMENT PLAN REVISION 2007

Sylvan Lake spring Tier II survey raw data as collected June 4, 2007.

DEPTH	FILALG	CERDEM	CHARA	ELOCAN	MYREXA	MYRSPI	NAJFLE	NAJGUA	POTCRI	POTGRA	POTPEC	POTZOS	VALAME	ZANPAL	X_COOR	Y_COOR
1.5			1											5	636460.6489	4594786.616
2.5	p	5													638448.7205	4594208.883
4	p	1													636567.8247	4594793.532
4	p							1	1						636194.535	4595441.161
4															635929.0036	4595752.596
4	p	3													636784.0693	4593804.551
4	p	1							1						638693.8024	4594396.819
4	p	3													638890.2991	4594471.143
4	p	5		3											638819.9628	4594637.411
5															636885.4397	4594301.747
5		1													636438.3819	4594411.174
5	p	1	1					1		1					636277.5607	4595191.494
5	p	5	1	1				1		1					635668.3136	4594852.574
5	p	1													636026.2438	4595048.929
5	p	1													636186.4553	4594519.458
5	p								1			1		1	636785.9278	4593983.092
5	p	5						1	1						637430.3561	4593761.936
6	p	1							1	1					637532.412	4594549.698
6	p	1													636675.2983	4594233.874
6		1			1	1		1	1	1	1				636641.8649	4594858.445
6		1							1					1	636128.1812	4595499.159
6	p	5				3									638803.8172	4594423.574
7		1													637353.1233	4594517.869
7															637112.2244	4594339.312
7	p								1	1		1			636398.7079	4594925.749
7	p								1					1	635816.7724	4594891.887
7	p	1					1		1						636313.9919	4594292.452
7	p								1						637667.3225	4594061.029
7															637655.4453	4594307.698
7	p								1						638512.6463	4594321.132
7	p	3							1						638766.6709	4594384.332
7	p	1						1							638685.3749	4594816.477
7	p	1						1	1						637861.2844	4594550.971
8	p	1													637263.6003	4594500.058
8									1				1		637001.8448	4594232.834
8	p	1											1		636361.0707	4594718.926
8	p	1													638168.8109	4594612.461
9		1	1												637627.0703	4594490.886
9															636367.8868	4595036.897
9															635961.2486	4594859.394
9	p														637715.3323	4593714.818

DEPTH	FILALG	CERDEM	CHARA	ELOCAN	MYREXA	MYRSPI	NAJFLE	NAJGUA	POTCRI	POTGRA	POTPEC	POTZOS	VALAME	ZANPAL	X_COOR	Y_COOR
10	p	1							1						637340.1565	4593856.562
11															636417.8306	4594349.142
11															636387.8267	4594840.946
11	p														636130.0267	4595426.371
11															635833.3278	4595070.925
11	p								1					1	636275.0237	4594809.594
11		1							1						638271.2997	4594515.661
12															636254.922	4594499.142
12		1													636267.6935	4594659.312
12	p												1		635699.6561	4594917.874
12															636140.4055	4594898.435
12	p														636870.8047	4593882.129
12	p								1						637402.1673	4594079.468
12	p	1							3	1					637488.8394	4593926.787
12	p	1			1				3						637992.3605	4593809.386
12	p	1													637519.1775	4594084.473
12.5		1													637399.8281	4594400.554
14															636814.8122	4594196.098
14															636329.6548	4595056.236
14															636313.0668	4594961.524
14									1						637012.8998	4593893.295
14	p	3				1			1						637765.6949	4593632.042
14															638037.6888	4593671.713
14															637488.6057	4594328.071
14	p	1													637858.9083	4594457.45
14										1					638532.5581	4594707.169
14	p	1													638415.1801	4594640.452
15	p														638168.8846	4593481.353
15															638278.4324	4594331.593
16		1				1									637287.5806	4594381.489
16															636308.2793	4594884.5
16															637003.1206	4594092.525
16	p	1		1					1						638631.5763	4594750.096
17															636211.1182	4595092.156
17															636144.6157	4594766.049
17															636867.7767	4594083.086
17	p														637162.002	4594083.01
17															637675.3079	4594455.327
19															638025.6644	4593713.786
21															637306.2518	4594039.927

Sylvan Lake summer Tier II survey raw data as collected July 26, 2007.

DEPTH	FILALG	CERDEM	CHARA	ELOCAN	MYREXA	MYRSPI	NAJFLE	NAJGUA	POTCRI	STUPEC	POTZOS	X_COOR	Y_COOR
2		5	1	3								635660.0467	4594851.9042
2												638444.8490	4594214.8319
3		3				1		1		1		637143.7407	4594365.8758
3		5	5			1	3	5		1		636637.4470	4594868.7160
3	p	1					1	1	1	1	1	636181.0507	4595428.7657
3	p	5	3			3		1				636786.6892	4593970.2836
3	p	5	3			3		1	1	1		636994.4226	4593881.1713
3	p	5	1			5		1		1		637692.1927	4593742.5654
3	p	3	1									638638.2287	4593190.1208
3	p		1					3		5	1	638579.8232	4593783.0339
4		1						1	1			637561.6631	4594559.8157
4	p					1						636915.5490	4594316.8074
4	p	1				1		1				636423.1159	4594775.0329
4	p	1	1									636326.7365	4595073.9570
4												636217.6092	4595203.2277
4		1										635938.4380	4595744.9889
4		1	5				1	3			1	636001.6369	4595067.8176
4		1						1	1	1	1	636339.3377	4594283.0884
4		5		1					1			638701.5807	4594417.8291
4		5	1	3								638709.4194	4594428.5536
4	p	5				1						638803.8447	4594595.3693
5		1	1			1						636405.9205	4594425.9588
5		3										636762.4591	4593832.5978
5	p	1	1			1						637315.2451	4593868.9114
5	p	1	1	3	1	1		1				638301.2805	4593311.1521
6	p	1										637379.8085	4594520.5106
6	p	1			1	1						637008.4244	4594254.3355
6		5	1			1		1		1	3	636151.9779	4595496.7455
6		3	1			1						635686.3573	4594959.4446
6		3	1	1						1		635785.2145	4594888.6047
6		5	1	1								637420.1021	4593765.7777
6		3	1			1						637655.8065	4594300.9916
6		5	1			1						638472.0891	4594305.3748
6	p	3	1									638757.3054	4594481.5144
6		5	1			1		1				638695.1642	4594798.4446
6		1										637630.6028	4594517.2550
7								1	1			636256.5672	4594496.8028
7		5	3			3				5	3	636555.8250	4594844.7978
7												636002.4105	4594888.8500
7	p					33			1			638446.9748	4593369.5220
7		5				1				1		638697.7593	4593312.2113
7	p	3							1	1		638376.0607	4593743.8230
7												637839.2493	4594467.8051
7		5	3	1								638783.7886	4594643.1716
7	p	1				1			1			638654.7090	4594792.5150

DEPTH	FILALG	CERDEM	CHARA	ELOCAN	MYREXA	MYRSPI	NAJFLE	NAJGUA	POTCRI	STUPEC	POTZOS	X_COOR	Y_COOR
7		5				1			1			637868.6593	4594544.4594
8		3				1				1		637271.7596	4594493.3054
8	p	1										636343.0956	4594704.2833
8												636192.5772	4594510.0760
8	p	1										637464.3468	4593927.2297
8		1				1				1	1	637779.9563	4593623.0766
8						3						638314.9919	4593459.4154
8												638265.3313	4594338.5614
9	p											635823.8878	4595066.2012
9												636860.3250	4593877.0296
9	p	1				3						638009.2753	4593800.6967
9	p	1	1									638550.0966	4594772.3485
9		1	1			1						638185.5824	4594643.9301
10										1		636337.8030	4595048.7607
10												636124.4267	4595415.2833
10		3										637656.1976	4594052.0395
11												636853.6771	4594065.5959
12		1										637340.3777	4594372.8794
12												636833.1128	4594198.7320
12	p											638172.6815	4593494.9821
12	p											638595.5435	4593506.1874
12												637380.6482	4594119.9700
12												637647.0662	4594448.4877
12												638255.1485	4594543.8263
13	p	1										636697.2295	4594195.4163
13	p											636400.4775	4594872.4483
13	p											637158.6733	4594132.4406
13												638399.9977	4594730.1586
14												637393.3387	4594394.0290
14												636433.6301	4594322.1309
14												636214.7581	4594662.2297
14												636241.5131	4594799.8305
14		1										637030.2827	4594064.1242
14												637286.6938	4594052.8444
14												638363.5100	4593523.0192
14		1										637505.1028	4594325.9954
15												636355.1288	4594854.1376
16												636339.0333	4594970.1350
16												636215.7392	4595093.8954
16												636159.4933	4594920.9016
16												638043.9289	4593693.9981
17												636301.7626	4594898.3597
17												636108.9571	4594773.2721
17												637518.6025	4594116.5285
18												638012.1868	4593658.3711

APPENDIX C:

TIER II SURVEY RESULTS

SYLVAN LAKE
AQUATIC PLANT MANAGEMENT PLAN REVISION 2007

Occurrence and abundance of submersed aquatic plants in Sylvan Lake.					
Total Sites:	81	Mean species / site:	1.25	Native diversity:	0.70
Littoral Sites:	74	Maximum species / site:	7	Species diversity:	0.78
Littoral Depth (ft):	16	Number of species:	13	SE Mean natives / site:	0.12
Date:	6/4/07	Littoral sites with plants:	51	Mean natives / site:	0.90
Lake:	Sylvan	Secchi(ft):	8.2	SE Mean species / site:	0.15

All depths (0-20')		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	46.91	53.09	35.80	4.94	6.17	16.30
Potamogeton crispus	Curly-leaf pondweed	29.63	70.37	27.16	2.47	0.00	6.91
Zannichellia palustris	Horned pondweed	6.17	93.83	4.94	0.00	1.23	2.22
Potamogeton gramineus	Grassy pondweed	8.64	91.36	8.64	0.00	0.00	1.73
Najas guadalupensis	Southern naiad	8.64	91.36	8.64	0.00	0.00	1.73
Myriophyllum spicatum	Eurasian watermilfoil	4.94	95.06	3.70	1.23	0.00	1.48
Elodea canadensis	Common water weed	3.70	96.30	2.47	1.23	0.00	1.23
Chara species	Chara species	4.94	95.06	4.94	0.00	0.00	0.99
Valisneria americana	Eel grass	3.70	96.30	3.70	0.00	0.00	0.74
Potamogeton zosteriformis	Flat-stem pondweed	2.47	97.53	2.47	0.00	0.00	0.49
Myriophyllum exalbescens	Northern watermilfoil	2.47	97.53	2.47	0.00	0.00	0.49
Potamogeton pectinatus	Sago pondweed	1.23	98.77	1.23	0.00	0.00	0.25
Najas flexilis	Slender naiad	1.23	98.77	1.23	0.00	0.00	0.25
Filamentous algae	Filamentous algae	53.09					

0-5' stratum		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	75.00	25.00	45.00	10.00	20.00	35.00
Zannichellia palustris	Horned pondweed	10.00	90.00	5.00	0.00	5.00	6.00
Potamogeton crispus	Curly-leaf pondweed	30.00	70.00	30.00	0.00	0.00	6.00
Najas guadalupensis	Southern naiad	25.00	75.00	25.00	0.00	0.00	5.00
Potamogeton gramineus	Grassy pondweed	20.00	80.00	20.00	0.00	0.00	4.00
Elodea canadensis	Common water weed	10.00	90.00	5.00	5.00	0.00	4.00
Chara species	Chara species	15.00	85.00	15.00	0.00	0.00	3.00
Potamogeton zosteriformis	Flat-stem pondweed	5.00	95.00	5.00	0.00	0.00	1.00
Potamogeton pectinatus	Sago pondweed	5.00	95.00	5.00	0.00	0.00	1.00
Myriophyllum spicatum	Eurasian watermilfoil	5.00	95.00	5.00	0.00	0.00	1.00
Myriophyllum exalbescens	Northern watermilfoil	5.00	95.00	5.00	0.00	0.00	1.00
Filamentous algae	Filamentous algae	75.00					

5-10' stratum		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	44.44	55.56	37.04	3.70	3.70	13.33
Potamogeton crispus	Curly-leaf pondweed	40.74	59.26	40.74	0.00	0.00	8.15
Myriophyllum spicatum	Eurasian watermilfoil	3.70	96.30	0.00	3.70	0.00	2.22
Zannichellia palustris	Horned pondweed	11.11	88.89	11.11	0.00	0.00	2.22
Najas guadalupensis	Southern naiad	7.41	92.59	7.41	0.00	0.00	1.48
Valisneria americana	Eel grass	7.41	92.59	7.41	0.00	0.00	1.48
Potamogeton zosteriformis	Flat-stem pondweed	3.70	96.30	3.70	0.00	0.00	0.74
Potamogeton gramineus	Grassy pondweed	3.70	96.30	3.70	0.00	0.00	0.74
Najas flexilis	Slender naiad	3.70	96.30	3.70	0.00	0.00	0.74
Chara species	Chara species	3.70	96.30	3.70	0.00	0.00	0.74
Filamentous algae	Filamentous algae	59.26					

10-15' stratum		Frequency of	Frequency per Species				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	41.67	58.33	37.50	4.17	0.00	10.00
Potamogeton crispus	Curly-leaf pondweed	25.00	75.00	16.67	8.33	0.00	8.33
Myriophyllum spicatum	Eurasian watermilfoil	8.33	91.67	8.33	0.00	0.00	1.67
Potamogeton gramineus	Grassy pondweed	8.33	91.67	8.33	0.00	0.00	1.67
Myriophyllum exalbescens	Northern watermilfoil	4.17	95.83	4.17	0.00	0.00	0.83
Valisneria americana	Eel grass	4.17	95.83	4.17	0.00	0.00	0.83
Filamentous algae	Filamentous algae	41.67					

15-20' stratum		Frequency of	Frequency per Species				
Species		**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Potamogeton crispus	Curly-leaf pondweed	10.00	90.00	10.00	0.00	0.00	2.00
Elodea canadensis	Common water weed	10.00	90.00	10.00	0.00	0.00	2.00
Ceratophyllum demersum	Coontail	10.00	90.00	10.00	0.00	0.00	2.00
Filamentous algae	Filamentous algae	20.00					

Occurrence and abundance of submersed aquatic plants in Sylvan Lake.

Total Sites:	90	Mean species / site:	1.79	Native diversity:	0.76
Littoral Sites:	80	Maximum species / site:	6	Species diversity:	0.83
Littoral Depth (ft):	14	Number of species:	10	SE Mean natives / site:	0.16
Date:	7/26/07	Littoral sites with plants:	56	Mean natives / site:	1.38
Lake:	Sylvan	Secchi(ft):	N/A	SE Mean species / site:	0.20

All depths (0-15')		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	55.56	44.44	26.67	11.11	17.78	29.78
Myriophyllum spicatum	Eurasian watermilfoil	30.00	71.11	22.22	5.56	1.11	16.22
Chara species	Chara species	27.78	72.22	21.11	4.44	2.22	9.11
Potamogeton gramineus	Grassy pondweed	16.67	83.33	14.44	0.00	2.22	5.11
Najas guadalupensis	Southern naiad	16.67	83.33	13.33	2.22	1.11	5.11
Elodea canadensis	Common water weed	7.78	92.22	4.44	3.33	0.00	2.89
Potamogeton pectinatus	Sago pondweed	7.78	92.22	5.56	2.22	0.00	2.44
Potamogeton crispus	Curly-leaf pondweed	11.11	88.89	11.11	0.00	0.00	2.22
Najas flexilis	Slender naiad	3.33	96.67	2.22	1.11	0.00	1.11
Myriophyllum exalbescens	Northern watermilfoil	2.22	97.78	2.22	0.00	0.00	0.44
Filamentous algae	Filamentous algae	31.11					

0-5' stratum		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	84.00	16.00	40.00	12.00	32.00	47.20
Chara species	Chara species	52.00	48.00	36.00	8.00	8.00	20.00
Najas guadalupensis	Southern naiad	48.00	52.00	36.00	8.00	4.00	16.00
Myriophyllum spicatum	Eurasian watermilfoil	44.00	56.00	32.00	8.00	4.00	15.20
Potamogeton gramineus	Grassy pondweed	28.00	72.00	24.00	0.00	4.00	8.80
Elodea canadensis	Common water weed	16.00	84.00	4.00	12.00	0.00	8.00
Potamogeton crispus	Curly leaf pondweed	20.00	80.00	20.00	0.00	0.00	4.00
Najas flexilis	Slender naiad	12.00	88.00	8.00	4.00	0.00	4.00
Potamogeton pectinatus	Sago pondweed	16.00	84.00	16.00	0.00	0.00	3.20
Myriophyllum exalbescens	Northern watermilfoil	4.00	96.00	4.00	0.00	0.00	0.80
Filamentous algae	Filamentous algae	48.00					

5-10' stratum		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	69.44	30.56	27.78	19.44	22.22	39.44
Myriophyllum spicatum	Eurasian watermilfoil	44.44	55.56	33.33	8.33	0.00	30.00
Chara species	Chara species	33.33	66.67	27.78	5.56	0.00	8.89
Potamogeton gramineus	Grassy pondweed	22.22	77.78	19.44	0.00	2.78	6.67
Potamogeton pectinatus	Sago pondweed	8.33	91.67	2.78	5.56	0.00	3.89
Potamogeton crispus	Curly leaf pondweed	13.89	86.11	13.89	0.00	0.00	2.78
Najas guadalupensis	Southern naiad	8.33	91.67	8.33	0.00	0.00	1.67
Elodea canadensis	Common water weed	8.33	91.67	8.33	0.00	0.00	1.67
Myriophyllum exalbescens	Northern watermilfoil	2.78	97.22	2.78	0.00	0.00	0.56
Filamentous algae	Filamentous algae	30.56					

10-15' stratum		**Frequency of**	**Frequency per Species**				
Scientific Name	**Common Name**	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Ceratophyllum demersum	Coontail	19.05	80.95	19.05	0.00	0.00	3.81
Filamentous algae	Filamentous algae	23.81					

APPENDIX D:

HYDRILLA INFORMATION

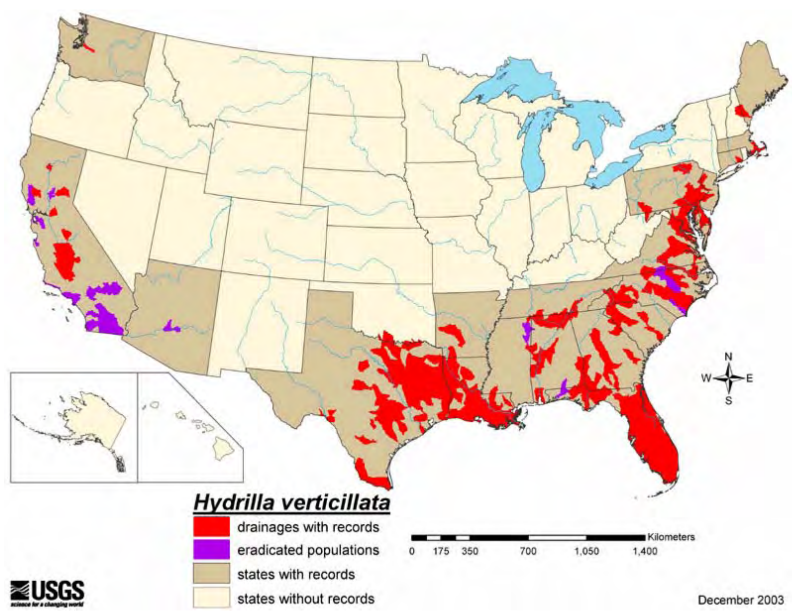
SYLVAN LAKE
AQUATIC PLANT MANAGEMENT PLAN REVISION 2007

AIS
Aquatic Invasive Species

HYDRILLA

COMMON NAME: Hydrilla
Hydrilla is also known as water thyme, Florida elodea, Wasserquirl and Indian star-vine.

SCIENTIFIC NAME: *Hydrilla verticillata* (L.f.) Royle
Hydrilla's scientific name is made up of the Greek word "hydro" meaning "water" and the Latin word "verticillus" that means "the whorl of a spindle". Appropriately named, it is an aquatic plant with leaves that are whorled around the stem. Hydrilla is in the Frog's Bit family, or Hydrocharitaceae. It is the only species of the genus *Hydrilla* in the world though it resembles many of the other species in the family.



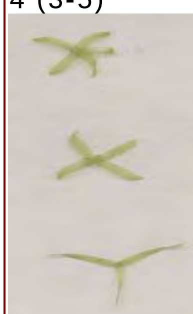
DISTRIBUTION: It is not really known where exactly hydrilla originated. Some sources give a broad native range of parts of Asia, Africa and Australia. Other sources are more specific and say that the dioecious form of hydrilla originated from the Indian subcontinent and the monoecious form originated from Korea. Currently the only continent without records of hydrilla is Antarctica.

Indiana: Hydrilla has not been detected in Indiana waters but it is on our Aquatic Nuisance Species watch list.

DESCRIPTION:

Leaves: Leaves are small about 2-4 mm wide and 6-20 mm long. They are strap-like with pointed tips and have visible saw-tooth margins. The leaves are whorled around the nodes in groups of 4-8 leaves. The leaf midvein is reddish in color and usually has a row of spines on it. This gives the plant a rough texture. The leaves are usually a green color, though topped out leaves could be bleached by the sun and appear more yellowish. Hydrilla has an axillary leaf scale called a squamula intravaginalis that is found next to the stem at the base of the leaf. This distinguishes it from the other species in the Hydrocharitaceae family. One may confuse hydrilla with another exotic weed, Brazilian elodea (*Egeria densa*). Hydrilla will have rough teeth on the underside of the leaves where Brazilian elodea will not. There is also a native species found in Indiana, American elodea (*Elodea canadensis*), which looks somewhat like hydrilla.

Identification Characteristics of the Hydrocharataceae

Character	**Brazilian Elodea** *(Egeria densa)*	**American Elodea** *(Elodea canadensis)*	**Hydrilla (monoecious)** (*Hydrilla verticillata*	**Hydrilla (dioecious)** (*Hydrilla verticillata)*
Leaves per Whorl	4 (3-5) 	3(2) 	5(2-8) 	4-5 (2-8) 
Serrated Edges Visible	With magnification	With magnification	Distinct on older plants	Distinct
Leaf Size	Up to 4cm	Up to 1.5 cm	1-2 cm	1-2 cm
Flowers	Male only, up to 2 cm	Tiny, male and female on separate plants	Male and female on same plants, to 1 cm	Only female plants in US, to 1 cm
Tubers Present	No	No	Yes	Yes

Roots/Stem: New root sprouts are white and when growing in highly organic soil they may be become brown. They are submerged and buried in the hydro-soil. Hydrilla stems are very slender only about 1/32 of an inch wide, but they can grow to lengths of 30 feet. When the stem nears the waters surface it branches out considerably. The monoecious form of hydrilla will usually start to branch out at the sediment level rather than at the top of the water.

Flowers: The flowers are imperfect (meaning there are separate male and female flowers) but the plant can be monoecious (flowers of both sexes on one plant) or dioecious (flowers of one sex being produced per plant). The female flower is white with three petals that alternate with three whitish sepals. The male flower has petals and sepals similar to the female flower, but the color could be white, reddish, or brown.

Fruits/Seeds: Hydrilla produce two different hibernacula to cover its buds. One is called a tuber, which forms terminally on rhizomes. They can be 5-10 mm long and are off white to yellow colored. Hydrilla also produces a turions which are compact dormant buds in the leaf axil. They are 5-8 mm long, dark green in color, and they appear to be spiny. The turion will break off and settle to the bottom of the water to start a new plant. The tubers are able to over winter and re-sprout as new plants as well. Seeds are also produced.

LIFE CYCLE BIOLOGY: Hydrilla is a submersed, herbaceous, perennial aquatic plant. It is capable of living in many different freshwater habitats. It will grow in springs, lakes, marshes, ditches, rivers, or anywhere there is a few inches of water. Hydrilla can tolerate low nutrient and high nutrient conditions as well as a salinity of up to 7%. Another adaptation hydrilla possesses, that enable it to out compete native plants, is the ability to grow in low light conditions. It is able to grow at deeper depths and can begin to photosynthesize earlier in the morning than most other aquatic plants. In the beginning stages of life hydrilla elongates at a rate of one inch per day. This continues until the plant comes close to the top of the water, here it begins to branch out. It produces a large mat of vegetation at the waters surface intercepting the light before it can reach other plants.

Hydrilla can reproduce in four different ways, fragmentation, tubers, turions, and seed. Fragmented pieces of hydrilla that contain at least one node are capable of sprouting into a new plant. The tubers of hydrilla are formed on the rhizomes and each one can produce 6,000 new tubers. When out of water a tuber can remain viable for several days, it can even lie dormant for over 4 years in undisturbed soil before sprouting a new plant. Turions are formed in the leaf axils of the plant. They are broken off and once settled in the sediment they can sprout into a new plant. Uncharacteristic of most plants, seed production in hydrilla is of least importance for reproduction. It seems that seed production is mostly used for long distance dispersal by means of ingestion by birds. The monoecious form of hydrilla puts more energy into tuber and turion production than does the dioecious form. It is good to know which form you have to decide on the best management technique.

The main adaptations that give hydrilla an advantage over other native plants are: it can grow at low light intensities, it is better at absorbing carbon dioxide from the water, it is able to store nutrients for later use, it can tolerate a wide range of water quality conditions, and it can propagate in four different ways.

PATHWAYS/HISTORY: Under the name Indian star-vine, hydrilla was imported into Florida as an aquarium plant in the 1950's. A farmer living near Tampa acquired the plant but was not impressed with it and threw it out into a canal behind his business. A few months later the farmer noticed that the hydrilla grew very well and decided to market it. By the 1960's severe problems caused by hydrilla were being reported. In 1990 hydrilla could be found in 187 lakes and rivers in Florida. Because there are two different strains of hydrilla found in the United States, the monoecious strain and the dioecious strain, it is believed that there was a separate introduction outside of Florida. The dioecious form is mainly found in the southern states and California and the monoecious form is found north of South Carolina. Hydrilla was brought to national attention in 1980 when it was discovered in the Potomac River in Washington D.C. Currently hydrilla is found in approximately 690 bodies of water within 190 drainage basins of 21 states.

DISPERSAL/SPREAD: Once established hydrilla can easily spread to new areas. Fragmented pieces of the plant are able to root and develop into a new plant. These plant fragments are transported to new waters via boats and fishing equipment. Hydrilla's tubers and turions allow it to persist in an area. They can live dormant in the ground and can even resist a drought. Waterfowl are a vector of transport for hydrilla as well. Some waterfowl feed on the plant and may regurgitate the tubers into other bodies of water. It has been found that these tubers are still able to sprout. Birds can also spread seeds. Hydrilla is still sold for aquarium use over the Internet, which could mean expansion of its range through more introductions, accidental or otherwise.

RISKS/IMPACTS: Hydrilla is sometimes called an invisible menace because most of the time you don't know it is there until it has filled the water. It will shade out native aquatic plants until they are eliminated. This forms a monoculture, which will reduce biodiversity and alter the ecosystem. Hydrilla does not only pose a threat to other plants but to animals as well. When hydrilla becomes over abundant, fish population imbalances are likely. The dense mats of hydrilla will alter the waters chemistry by raising pH, cause wide oxygen fluctuations, and increase water temperature.

Hydrilla is an economic drain. Millions of dollars are lost due to reduced recreational opportunities as hydrilla mats interfere with boating, swimming, fishing, etc. In flowing waters hydrilla will greatly reduce flow and can cause flooding. For operations that require water intake, hydrilla can pose a problem by clogging the intake pipes. Waterfront property values drop in areas infested with hydrilla. Millions of dollars are annually spent trying to control this aquatic pest.

MANAGEMENT/PREVENTION: Control of aquatic weeds is difficult and eradication sometimes can be an unrealistic goal. Before any type of management technique can be implemented there needs to be a positive identification of the plant. Some native plants look similar to hydrilla so it is important to have proper identification.

Hydrilla has not yet appeared in Indiana, however it is not far away. If this plant shows up in Indiana waters, it needs to be eliminated immediately. While there are many methods available to control aquatic plants, the method most suitable for complete and fast elimination is chemical control. Aquatic herbicides containing the active ingredient endothall, fluridone, or diquat are all labeled for use on hydrilla.

For states that have major infestations of this pest plant, they have looked to hydrilla's native range for any insects that could be used as a biological control. Four hydrilla-attacking insects have been released. *Bagous affinis*, a hydrilla tuber-attacking weevil and *Hydrellia pakistanae*, a leaf-mining fly both were released in 1987. *Hydrellia balciunasi* is another leaf mining fly that was released in 1989. *Bagous hydrillae*, a stem-mining weevil, was released in 1991. Many different states have released one or a combination of the four insects. It is still too early to know what long-term impacts these insects will have on hydrilla. One Indiana company is helping to develop a biological control method for hydrilla. SePro Inc. of Carmel, Indiana is a cooperator in a project with U.S. Army Engineer Research and Development Center Environmental Laboratory to grow an endemic fungal pathogen that attacks hydrilla.

Hydrilla has been listed by the U.S. government as a Federal Noxious Weed. With this designation, it is illegal to import or sell the plant in the United States. However, it is likely that internet sales still occur.

Like all invasive species, the key to preventing their spread is knowledge! You can also help by practicing a few good techniques to stop the spread of hydrilla and other aquatic invasive plants.

- ✓ Rinse any mud and/or debris from equipment and wading gear and drain any water from boats before leaving a launch area.

- ✓ Remove all plant fragments from the boat, propeller, and boat trailer. The transportation of plant material on boats, trailers, and in livewells is the main introduction route to new lakes and rivers.

- ✓ Do not release aquarium or water garden plants into the wild, rather seal them in a plastic bag and dispose in the trash.

- ✓ Consider using plants native to Indiana in aquariums and water gardens.

- ✓ If you detect this plant in a lake, pond, or stream, immediately contact the Indiana Department of Natural Resources, Division of Fish and Wildlife.
    - (317)232-4080
    - dkeller@dnr.IN.gov
    - 402 W. Washington St., Rm W273
Indianapolis, IN 46204

REFERENCES:

Balciunas, J.K., M.J. Grodowitz, A.F. Confrancesco, and J.F. Shearer. Hydrilla. 5 Nov 2003. Invasive.org. 30 June 2004. <www.invasive.org/eastern/biocontrol/7Hydrilla.html>.

Jacono, C.C. and M.M. Richerson. *Hydrilla verticillata*. 18 Dec 2002. U.S. Geological Survey. 30 June 2004. <nas.er.usgs.gov/plants/docs/hy_verti.html>.

Langeland, K.A. 1996. *Hydrilla verticillata* (L.F.) Royle (Hydrocharitaceae), "The Perfect Aquatic Weed". Castanea 61:293-304. 1 July 2004. <aquat1.ifas.ufl.edu/hydcirc.html>.

McCann, James A., Lori N. Arkin, and James D. Williams. Nonindigenous Aquatic and Selected Terrestrial Species of Florida. March 1996. University of Florida. 1 July 2004. <plants.ifas.ufl.edu/mcplnt1a.html>.

Non-Native Freshwater Plants:Hydrilla. 24 Feb 2003. Washington State Department of Ecology. 1 July 2004. <www.ecy.wa.gov/programs/wq/plants/weeds/aqua001.html>.

Ramey, Victor. Non-Native Invasive Aquatic Plants in the United States. Aug 2001. Center for Aquatic and Invasive Plants, University of Florida and Sea Grant. 1 July 2004. <plants.ifas.ufl.edu/seagrant/hydver2.html>.

Species Profiles-Hydrilla. 20 May 2004. National Agricultural Library. 1 July 2004. <invasivespecies.gov/profiles/hydrilla.shtml>.

Swearingen, J., K. Reshetiloff, B. Slattery, and S. Zwicker. Plant Invaders of Mid-Atlantic Natural Areas:Hydrilla. 2002. National Park Service and U.S. Fish and Wildlife Service. 1 July 2004. <www.nps.gov/plants/alien/pubs/midatlantic/hyve.htm>.

PHOTOGRAPHS compliments of the Washington Department of Ecology

Updated 3/05

APPENDIX E:

2008 AQUATIC PLANT TREATMENT PERMIT APPLICATIONS

SYLVAN LAKE
AQUATIC PLANT MANAGEMENT PLAN REVISION 2007

APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT

State Form 26727 (R / 11-03)
Approved State Board of Accounts 1987

x Whole Lake ☐ Multiple Treatment Areas
Check type of permit

INSTRUCTIONS: Please print or type information

FOR OFFICE USE ONLY
License No.
Date Issued
Lake County

Return to:
DEPARTMENT OF NATURAL RESOURCES
Division of Fish and Wildlife
Commercial License Clerk
402 West Washington Street, Room W273
Indianapolis, IN 46204

FEE: $5.00

Applicant's Name	Lake Assoc. Name: Sylvan Lake Improvement Association	
Rural Route or Street: PO Box 696		Phone Number
City and State: Rome City, Indiana		ZIP Code: 46784
Certified Applicator (if applicable)	Company or Inc. Name: Weed Patrol, Inc.	Certification Number
Rural Route or Street		Phone Number
City and State		ZIP Code

Lake (One application per lake): Sylvan Lake	Nearest Town: Rome City	County: Noble
Does water flow into a water supply		☐ Yes ☐ No

Please complete one section for *EACH* treatment area. Attach lake map showing treatment area and denote location of any water supply intake.

Treatment Area # 1 | LAT/LONG or UTM's

Total acres to be controlled: 300 | Proposed shoreline treatment length (ft) | Perpendicular distance from shoreline (ft)

Maximum Depth of Treatment (ft): 12 | Expected date(s) of treatment(s): April - May

Treatment method: X Chemical ☐ Physical ☐ Biological Control ☐ Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Aquathol K

Plant survey method: X Rake X Visual ☐ Other (specify) Formal Plant Survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Curlyleaf Pondweed	X	30%

Treatment Area # 2	LAT/LONG or UTM's		
Total acres to be controlled 25	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)	
Maximum Depth of Treatment (ft) 10	Expected date(s) of treatment(s) April - May		

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Renovate 3, Renovate OTF, 2,4-D

Plant survey method: [X] Rake [X] Visual [ ] Other (specify) Formal plant survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil	X	5%

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

FOR OFFICE ONLY

[ ] Approved [ ] Disapproved	Fisheries Staff Specialist
[ ] Approved [ ] Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204

Treatment Area #	3	LAT/LONG or UTM's	
Total acres to be controlled	< 30	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	5	Expected date(s) of treatment(s)	

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Reward

Plant survey method: [X] Rake [X] Visual [ ] Other (specify) Formal plant survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Coontail	X	47%

Treatment Area #	4	LAT/LONG or UTM's	
Total acres to be controlled	50	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	5	Expected date(s) of treatment(s)	

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Copper Sulfate, Cygnet Plus

Plant survey method: [X] Rake [X] Visual [ ] Other (specify) Formal plant survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Filamentous Algae	x	53%
Chara Algae	x	5%